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# Traditional Villages in Forest Areas: Exploring the Spatiotemporal Dynamics of Land Use and Landscape Patterns in Enshi Prefecture, China

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**Abstract:** In the context of the implementation of rural revitalization strategies in China, limited attention has been paid to the landscape patterns of traditional villages that are located in vulnerable environments. This study explores the land-use dynamics and landscape patterns of traditional villages in Enshi Prefecture, China. Based on a spatiotemporal analysis of land use and landscape metrics, we analyzed the prefecture and the environment surrounding 73 traditional villages. The results show that, from 2000 to 2020, most villages have had an increased share of forest, a decreased share of cultivated land and grassland, and a decreased level of landscape diversity and fragmentation. Additionally, villages at a higher elevation or with a steeper slope are associated with a lower level of landscape diversity, a lower proportion of cultivated land and grassland, and a higher proportion of forest. Overall, although the environment around the villages does not show dramatic changes in landscape patterns, land-use change at the prefecture level shows an increasing rate of urban growth from 2010 to 2020. For remote traditional villages in ecologically vulnerable and less-developed areas, caution is needed in the tradeoff between environmental conservation and economic development.

**Keywords:** traditional villages; landscape pattern; land-use change



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## 1. Introduction

China has experienced rapid urbanization during recent decades. Many cities have achieved high levels of development. However, the development of some remote rural areas, particularly at the village level, has been slow and problematic [1]. Many rural areas are suffering from inefficient land use and degraded environmental conditions [2–4]. Some historical villages have even vanished in the process of urbanization [5]. Rural areas are of critical economic, social, cultural, and ecological value. An agriculture ecosystem can provide multiple ecosystem services, such as food production, the maintenance of soil productivity, water regulation, aesthetics, and cultural identity [6–10]. They are key to sustainable and resilient development in these regions [2]. China has implemented a rural revitalization strategy, which aims to build sustainable and competitive rural regional systems with regard to the rural population, land, and industry [1,2]. This ambition calls for multidisciplinary research and practice, including in agriculture, geography, management, ecology, sociology, and engineering [2].

In order to revitalize rural areas in China, many practitioners and scholars have paid specific attention to traditional villages [11–15]. By the end of 2018, there were 6799 authorized traditional villages on the Chinese Traditional Villages list [11]. In addition to general rural areas, traditional villages have both a material and non-material cultural heritage and offer historical, cultural, and technical values [10,14]. To preserve and revitalize traditional villages, previous studies have mostly focused on the preservation of historical buildings and artifacts, the development of traditional techniques and educational activities, and the exploration of aesthetic and recreational values [5]. For example, exploring nature-based recreation in rural areas is widely considered an effective way to revitalize traditional villages, and scholars have designed different types of tourism strategies and models for these villages to alleviate poverty and maintain their vitality [10,11]. Others have focused on the spatial morphology of traditional villages [16,17]. However, there are insufficient studies focusing on the conservation of the wider landscape in which traditional villages are embedded [13].

Most traditional villages are dependent on the natural environment for their resources, forming a harmonious human–nature relationship [18]. Both natural disasters and human-related destruction affect the sustainable development of villages, resulting in biodiversity loss, soil erosion, rural depopulation, the "hollow villages" phenomenon, as well as other issues [4,19,20]. Therefore, the preservation of traditional villages should not be limited to their heritage but also the ecological sustainability of their environment. A recent research suggests that the protection of traditional settlements should not be restricted by their administrative boundaries. An integrated protection of both the cultural and natural landscape is necessary in the rapid urbanization process [15]. Many mountainous rural areas in China suffer from restricted cultivated land, an ecologically vulnerable environment, and poverty [21]. Although it is necessary to alleviate poverty through revitalization projects, some vulnerable areas are sensitive to land-use change because human-related destruction would lead to geological disasters (e.g., soil erosion caused by deforestation) [18,20]. In the context of rapid urbanization, land use and cover change (LUCC) is a clear reflection of human activities and socioeconomic transformations. Studies focused on urban–rural land-use transitions have found that location, natural resources, and socioeconomic conditions are the main determinants of urban–rural transformation at a county/district level [4]. Different patterns of land use are associated with the services that the ecosystem can provide, which further influences the human–nature relationship [20]. For instance, while an agriculture-dominant environment can provide food and other products, landscape patterns tend to be less diverse and, thus, potentially damaging to other ecological functions [9]. For counties in mountainous areas, an appropriate proportion of forest and grassland is found to be significantly related to the spatial heterogeneity of ecosystem service values [22]. A spatiotemporal analysis of LUCC can help with the monitoring and investigation of land-use dynamics and characteristics [23]. Furthermore, analyses based on landscape metrics are found to be effective in quantifying landscape patterns and helping to design land management strategies [24–28]. Different landscape metrics can reflect the characteristics of landscape patterns, such as landscape diversity, composition, and the level of fragmentation [29]. When landscape metrics are considered in a spatiotemporal analysis, they can serve as indicators to understand the evolution of the landscape. Some studies already exist that have analyzed LUCC and the landscape metrics of rural areas [20,21,23,30], such as the protection of cultivated land against the background of urbanization [19]. More attention should be paid to the landscape patterns of traditional villages that are located in vulnerable environments.

Against the background of rural revitalization and traditional village preservation, this study explores land-use dynamics and landscape patterns in the traditional villages of Enshi Prefecture in Hubei Province, China. Enshi Prefecture is located in a vulnerable, mountainous region where geological disasters happen frequently (e.g., landslides) [31,32]. It is the prefecture in Hubei Province in which national traditional villages are the most densely distributed. Many traditional villages are rich in cultural and natural resources [15]. A better understanding of the land-use dynamics and landscape patterns around traditional villages in vulnerable environments is vital for the comprehension of ecological processes and people's lifestyles in rural areas [28,33] and, therefore, for the design of effective planning strategies [24]. By taking the traditional village environment in Enshi Prefecture as a case study, this research aims to answer the following questions: What have been the characteristics of land-use change in Enshi Prefecture in the past twenty years? How have the landscape patterns around traditional villages in Enshi Prefecture changed? Finally, what are the relationships between the landscape patterns and territorial factors?

## 2. Materials and Methods

### *2.1. Study Area*

Enshi Prefecture (Enshi Tujia and Miao Autonomous Prefecture) is located in the mountainous southwest corner of Hubei Province in central China (Figure 1). It contains two cities (Enshi City, the prefectural seat, and Lichuan City) and six counties (Xianfeng County, Laifeng County, Badong County, Jianshi County, Hefeng County, and Xuan'en County). The total area of Enshi Prefecture is 24,100 km$^2$ with a population of 4.02 million (in 2019). Enshi Prefecture has a subtropical monsoon mountain climate with a mean annual temperature of 16.2 °C and a mean annual precipitation of 1600 mm. The terrain is complex with a varying elevation (source: http://www.enshi.gov.cn/zq/, accessed on 1 November 2020). Partly due to its inconvenient location in terms of transportation, many traditional villages are well kept as well as rich in heritage and cultural resources [12].

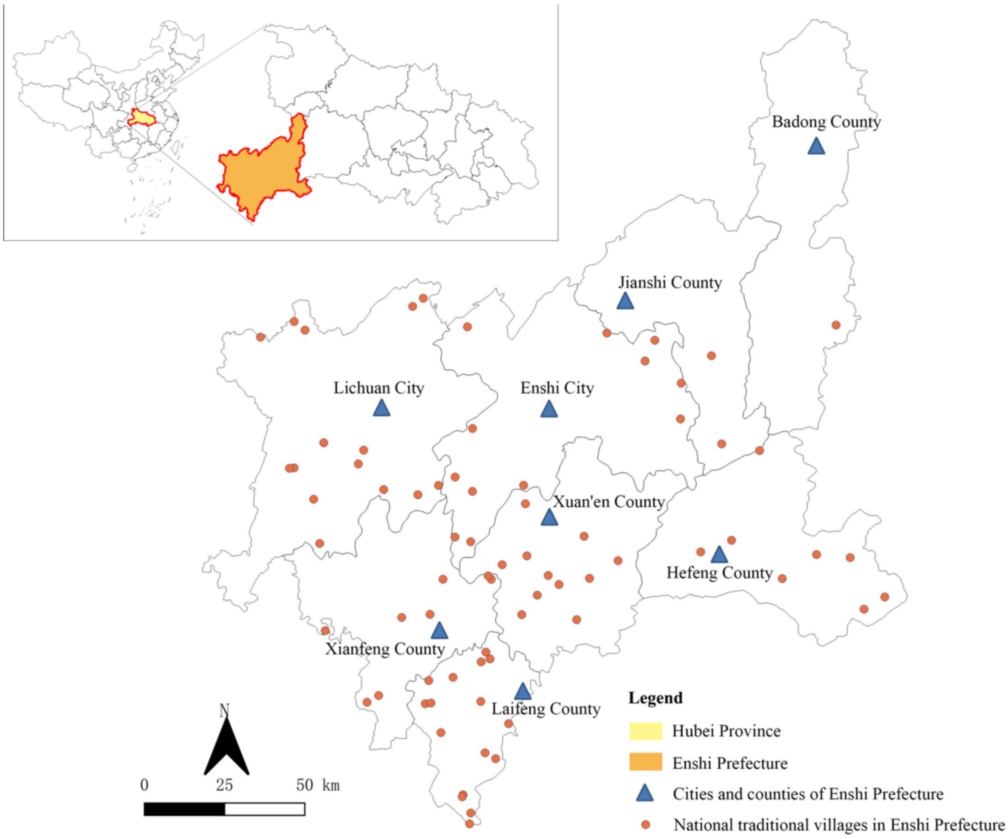


**Figure 1.** Location of Enshi Prefecture and the 73 national traditional villages.

One of the reasons for choosing Enshi Prefecture as the study area is because this prefecture has the highest share of traditional villages in Hubei Province. Up to December 2018, 205 national traditional villages had been approved in Hubei Province, of which 81 are in Enshi Prefecture [12]. Most traditional villages are located in Lichuan City, Xuan'en County, and Laifeng County. For this study, we have selected only 73 of the traditional villages in Enshi Prefecture because the land-use data for eight villages between 2000 and 2010 were not available from our data source. Another critical reason is that Enshi Prefecture is located in a vulnerable area that suffers from both geological disasters and anthropogenic impacts (i.e., pollution from industry) [34]. Enshi Prefecture has rich ecological and tourism resources. Over the last decade, the government of Hubei Province has been developing a "Western Hubei Eco-cultural Tourism Circle", and Enshi Prefecture is one of the key areas [34]. Under the pressure of developing tourism resources, it is possible that there could be a tradeoff between ecological conservation and tourism development as well as some changes to land-use patterns. Therefore, it is important to investigate the dynamics of land use and landscape patterns in Enshi Prefecture to establish the implications for environmental conservation and rural revitalization.

*2.2. Data Sources and Analysis*

This study investigates the dynamics of LUCC and landscape patterns around 73 national traditional villages in Enshi Prefecture based on Geographic Information Systems (GIS). The study design contains three steps: investigating the spatiotemporal LUCC in Enshi Prefecture in 2000, 2010, and 2020; calculating the landscape metrics within a buffer zone around each of the 73 villages; and analyzing the associations between landscape metrics and territorial variables.

First, to investigate the spatiotemporal LUCC, we used the GlobeLand30 dataset (http://www.globallandcover.com, accessed on 4 November 2020), which is available for the years 2000, 2010, and 2020, with an original resolution of 30 m. The classification of land use based on the dataset includes cultivated land, forest, grassland, shrubland, wetland, water bodies, tundra, artificial surface, bare land, and permanent snow and ice [35]. Land use in Enshi Prefecture for the years 2000, 2010, and 2020 and the LUCC were analyzed. Spatiotemporal LUCC analysis was conducted using software QGIS 3.16 and R 4.0 through packages [36–38].

Second, in order to measure the landscape patterns around the 73 villages, four landscape metrics—percentage of landscape (PLAND), Shannon's diversity index (SHDI), patch density (PD), and edge density (ED)—were selected based on previous studies [20,25,26,39–42] (see Table 1). PLAND was measured at the class level and the other three were measured at the landscape level. PLAND is a simple measure of landscape composition by calculating the percentage of different landscape classes. SHDI is a frequently used metric in landscape ecology, and it measures the diversity and heterogeneity of land covers [29]. A decrease in SHDI can be interpreted as habitat loss [43]. As regards PD, a higher PD value indicates a more fragmented landscape pattern. ED can also be a measure of fragmentation [43,44]. A higher degree of fragmentation is usually considered as a result of an increase in human activities [41]. Overall, landscape metrics can provide a quantitative perspective to investigate, understand, and compare the ecological patterns according to land use. These four metrics are widely used to measure the different characteristics of landscape structures and processes [26,29,40,45]. For instance, one study used SHDI and PD to objectively measure landscape diversity, and the authors found that these landscape metrics were valid after comparing them with the results of subjectively measured landscape aesthetics [26]. The four selected metrics were measured within a 3000 m straight-line buffer around each of the 73 villages, because this buffer zone usually covered the villages' administrative boundaries and their surroundings and, also, standardized our analytical units. When landscape metrics are calculated based on the same data source in the normalized spatial units for different time points, the results can be compared to reflect the changes and the characteristics of landscape patterns. All landscape metrics were calculated using the *Landscapemetrics* package [46] in the R 4.0 software. Boxplots were created to describe the distribution of the values.

Third, three territorial variables—elevation, slope, and distance to the nearest urban center—were selected to analyze their associations with the calculated landscape metrics for 2020. Elevation and slope were selected because many traditional villages in Enshi Prefecture are located in mountainous areas. Elevation and slope are frequently analyzed factors in studies that focus on landscape changes of mountains and mountainous regions [21,22,48,49]. It is possible that villages at different elevations and slopes have different ecological structures, agricultural activities, and convenience for transportation and, therefore, different landscape patterns [21]. In this study, elevation and slope data were obtained from the ASTER global digital elevation model (Vision 2) [50]. The mean elevation and slope of the buffer zones were calculated using QGIS 3.16. The selection of distance to the nearest urban center was based on the assumption that villages near urban areas might have more opportunities for development and tighter economic connections with cities, leading to a changing landscape. For instance, previous studies have found that location is one of the main determinants of rural land-use change [4]. Here, the urban center refers to the eight city and county centers in Enshi Prefecture, and Euclidian distances between the villages and their nearest urban center were calculated. Pearson's correlation was calculated using R 4.0 in order to measure the relationships between the six landscape metrics and the three territorial variables.

**Table 1.** Selected landscape metrics.

| Metric Name | Category | Description [26,29,40] | Justification [29,47] |
|---|---|---|---|
| Percentage of landscape (PLAND) | Area and edge | The percentage of the landscape belonging to a given class. Unit: Percent. | A measure of composition. |
| Shannon's diversity index (SHDI) | Diversity | An index that accounts for both the number of classes and the abundance of each class. Unit: none. | A measure of diversity. |
| Patch density (PD) | Aggregation | The number of patches per area unit. Unit: Number per 100 hectares. | A measure of composition (fragmentation). |
| Edge density (ED) | Area and edge | The sum of the length of all edges of different classes per area unit. Unit: Meters per hectare. | A measure of configuration (density). |

## 3. Results

### *3.1. Land Use and Cover Change in Enshi Prefecture*

The land-use patterns in Enshi Prefecture from 2000 to 2020 are presented in Figure 2. According to the categorization of land-use data, six categories emerged in our study area, namely forest, cultivated land, grassland, waterbodies, artificial surfaces, and wetland. The artificial surfaces category includes any surfaces formed by human-built activities, e.g., urban and rural settlements, industry, and transportation land use. Overall, 82.53% of the whole area has maintained the same use of land in the last two decades. From 2000 to 2010, grassland reduced notably, and forest increased. From 2010 to 2020, a discernable increase in artificial surfaces can be observed, and the locations where the artificial surfaces increased the most roughly match the areas of Enshi Prefecture's eight urban centers (as shown in Figure 1).

Table 2 presents the detailed land-use structure in 2000, 2010, and 2020. It is clear that the dominant land use is forest. The proportion of forest increased from 2000 to 2010 but decreased a little during the second period. The proportion of cultivated land did not show obvious changes. Grassland covered 8.96% of the prefecture in 2000, and it had fallen to 3.37% by 2010 and then maintained a similar level until 2020. The proportion of water bodies kept increasing from 2000 to 2020. The proportion of artificial land remained the same between 2000 and 2010; however, it increased dramatically between 2010 and 2020 (with a net gain of 233.9%). This indicates an increasing trend in local human activities. Wetland only constituted a very small percentage of local land use (0.0006% in 2000); however, it continued to decrease during the two time periods.

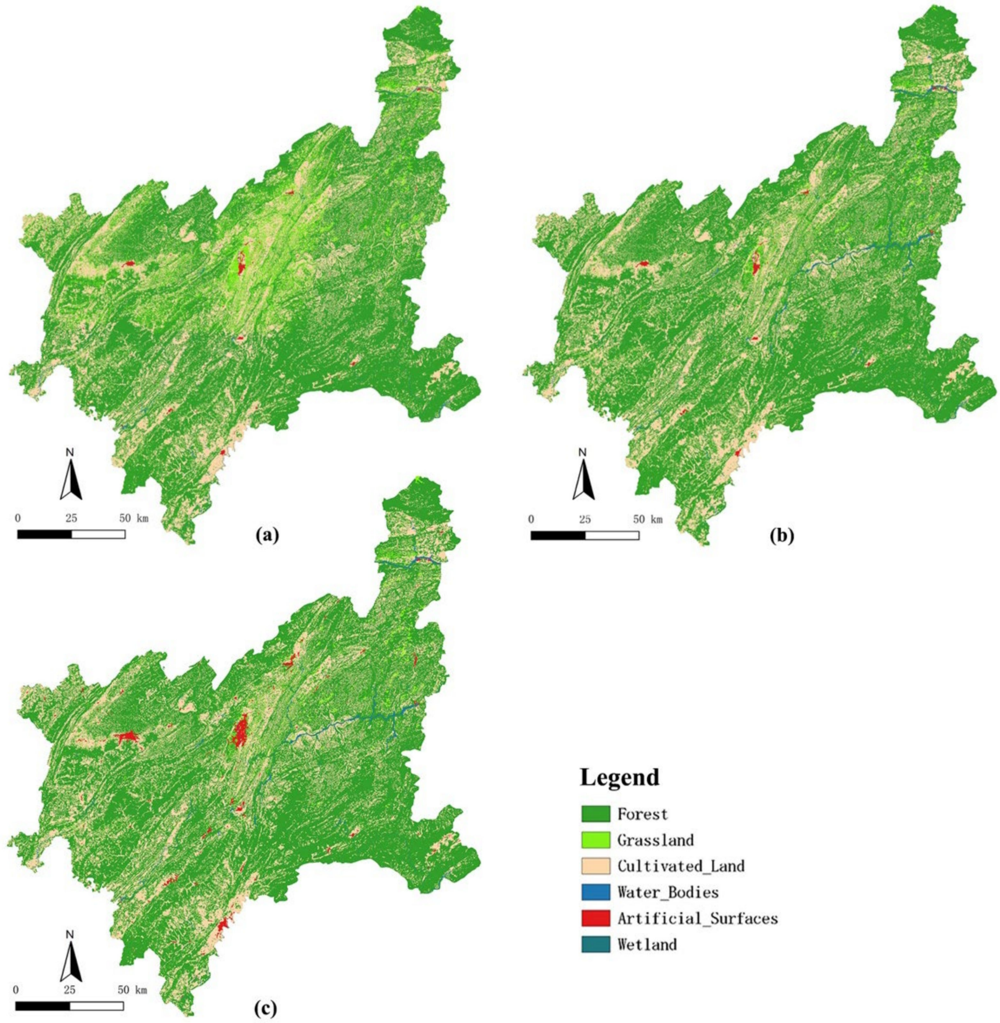


**Figure 2.** Land-use patterns and changes in Enshi Prefecture from 2000 to 2020. (**a**) Land-use patterns in 2000; (**b**) Land-use patterns in 2010; (**c**) Land-use patterns in 2020.

**Table 2.** Land-use structures in Enshi Prefecture from 2000 to 2020.

| Land Use | 2000 | | 2010 | | 2020 | | Net Gain/Loss (%) |
|---|---|---|---|---|---|---|---|
| | ($km^2$) | (%) | ($km^2$) | (%) | ($km^2$) | (%) | |
| Forest | 14,852.9 | 61.67 | 16,148.2 | 67.05 | 16,109.8 | 66.89 | +8.46 |
| Cultivated land | 6907.9 | 28.68 | 6918.2 | 28.73 | 6796.0 | 28.22 | −1.62 |
| Grassland | 2158.4 | 8.96 | 812.7 | 3.37 | 785.9 | 3.26 | −63.59 |
| Water bodies | 98.0 | 0.41 | 138.2 | 0.57 | 171.9 | 0.71 | +75.33 |
| Artificial surfaces | 65.8 | 0.27 | 65.8 | 0.27 | 219.6 | 0.91 | +233.90 |
| Wetland | 0.15 | 0.0006 | 0.005 | 0.00002 | 0.003 | 0.00001 | −98.18 |

The Sankey multistep diagram (Figure 3) indicates the detailed transitions between the different land-use categories. From 2000 to 2010, transitions occurred between artificial surfaces, cultivated land, forest, grassland, and water bodies. A notable share of grassland was converted to forest. Wetland was the only category that did not have any transitions from other land-use categories in 2010. Over half of the wetland area was transitioned into grassland. From 2010 to 2020, a more intensive transition between forest and cultivated land can be observed.

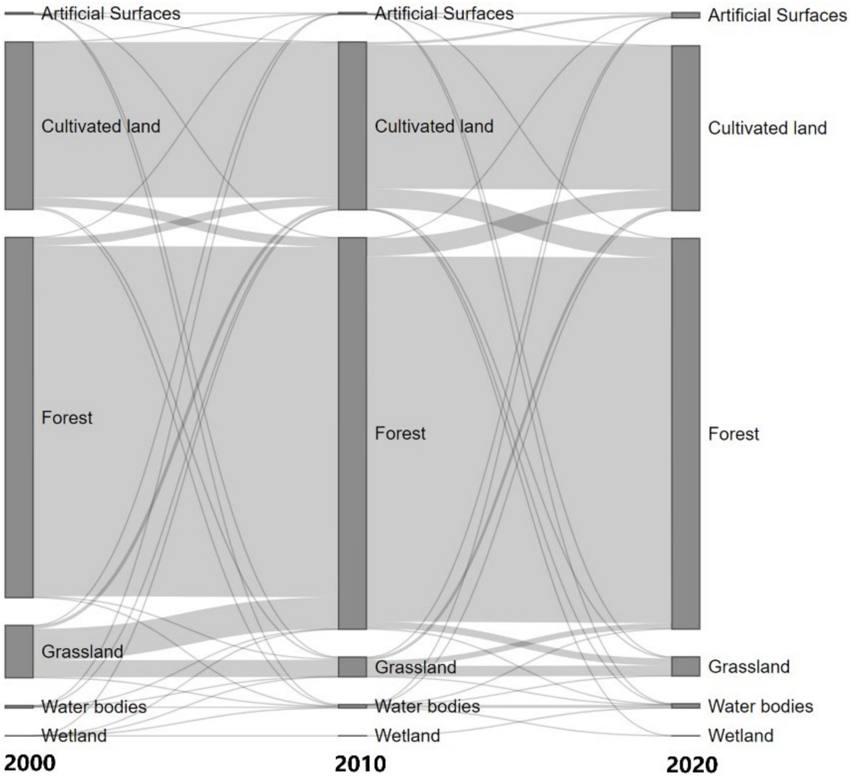


**Figure 3.** Land-use changes between categories in Enshi Prefecture from 2000 to 2020.

### *3.2. Landscape Metrics of the Buffer Zones of Traditional Villages*

#### 3.2.1. Percentage of Landscape around Villages

As seen in the land-use patterns above, forest, cultivated land, and grassland occupied over 98% of the overall area of Enshi Prefecture. Therefore, these three land-use categories were selected to calculate the PLAND of the 3 km buffer zones around the 73 traditional villages. The changes in the PLAND of the forest, cultivated land, and grassland show different trends (Figure 4).

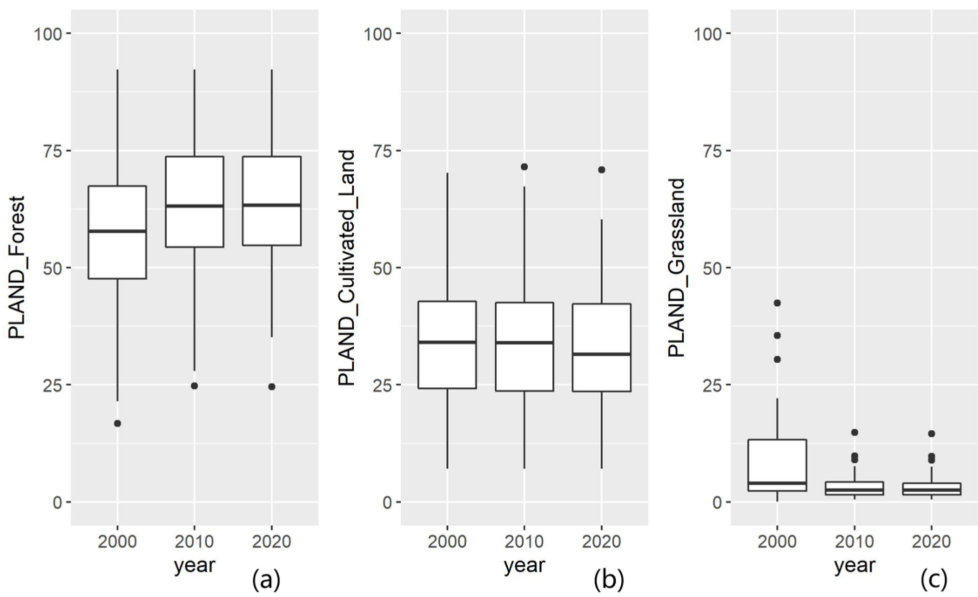


**Figure 4.** Boxplots of the results of the percentage of landscape (PLAND) of the 73 village buffer zones in 2000, 2010, and 2020. (**a**) PLAND of forest; (**b**) PLAND of cultivated land; (**c**) PLAND of grassland.

Figure 4a indicates that forest is the dominant landscape in most village buffer zones because over half of the villages had a share of forest above 57.59% in 2000, 63.12% in 2010, and 63.28% in 2020 (Table 3). The overall range of the PLAND of forest increased notably from 2000 to 2010, with 53 (72.6%) of the villages exhibiting an increasing trend from 2000 to 2020 and Gunlongba Village seeing the largest increase (32.9%). In terms of cultivated land use, 55 (75.3%) of the villages witnessed a decrease from 2000 to 2020, with Xinchang Village witnessing the greatest decrease (7.34%). The range of the proportion of cultivated land did not show a clear change, except a discernible decrease in the median value, which decreased from 33.98% in 2010 to 31.51% in 2020. The PLAND of grassland of the 73 village buffer zones showed clear differences in the data range between 2000 and the later years (Figure 4c). The distribution of data is much more compressed in 2010 and 2020, with lower median values. Overall, 45 (61.6%) villages had a decreasing trend in the proportion of grassland, with Gunlongba Village experiencing the largest decrease (32.71%).

**Table 3.** Summary of the median values of PLAND at the class level.

| Year | Median of PLAND | | |
|---|---|---|---|
| | Forest | Cultivated Land | Grassland |
| 2000 | 57.79 | 34.03 | 4.02 |
| 2010 | 63.12 | 33.98 | 2.59 |
| 2020 | 63.28 | 31.51 | 2.56 |

3.2.2. Results of Shannon's Diversity Index, Patch Density, and Edge Density

The results of SHDI, PD, and ED of the 73 village buffer zones are shown in Figure 5. The SHDI median of the villages showed a clear decrease from 2000 (0.84) to 2010 (0.75), and then it increased slightly from 2010 to 2020 (0.78) (Table 4). Overall, 49 (67.1%) villages had a decrease in SHDI from 2000 to 2020, with Xiangyang Village seeing the largest decrease (0.387). This suggests that most villages had a decrease in landscape diversity.

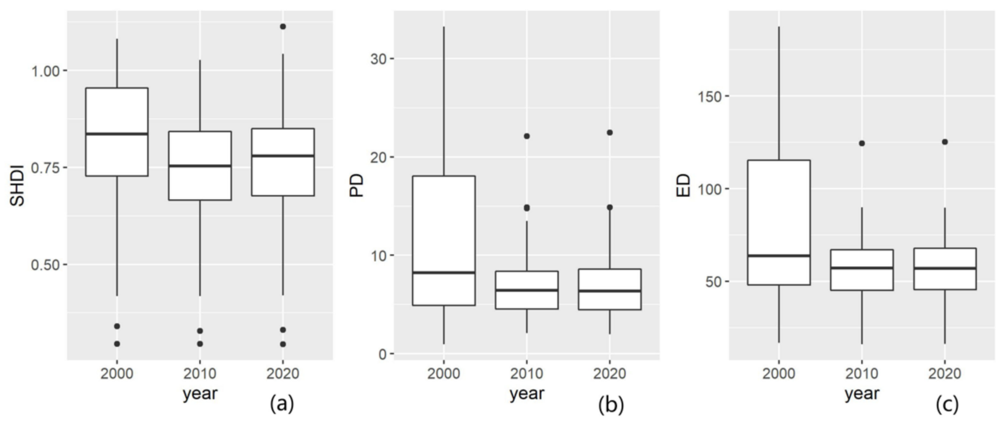


**Figure 5.** Boxplots of the results of the three landscape metrics of the 73 village buffer zones in 2000, 2010, and 2020. (**a**) Results of Shannon's diversity index (SHDI); (**b**) results of patch density (PD); (**c**) results of edge density (ED).

**Table 4.** Summary of the median values of SHDI, PD, and ED at the landscape level.

| Year | Median of SHDI | Median of PD | Median of ED |
|---|---|---|---|
| 2000 | 0.84 | 8.22 | 63.70 |
| 2010 | 0.75 | 6.44 | 57.08 |
| 2020 | 0.78 | 6.36 | 57.03 |

The values of PD (Figure 5b) and ED (Figure 5c) showed similar distributions in that their ranges were more stretched and skewed in 2000 than in 2010 and 2020. The interquartile range of PD distribution decreased heavily from 2000 to 2010, with 53 (72.6%) villages experiencing a decreasing trend, which means most villages had a decreased level of landscape fragmentation. Xiangyang Village saw the greatest decrease (24.39 per 100 ha). Regarding the ED results, 48 (65.8%) villages had a decrease from 2000 to 2020, and Shiban Village had the largest decrease (136.62 m/ha).

### 3.2.3. The Relationship between Landscape Metrics and Territorial Variables

Table 5 presents the results of Pearson's correlation between the six landscape metrics and the three territorial variables. Values of the six metrics for the year 2020 were used. The mean distance between the villages and their nearest urban center is 26,302 m, the mean elevation of the village buffer zones is 914 m, and the mean slope is 20.6 degree. Elevation is found to be negatively correlated with SHDI, PLAND of cultivated land, and PLAND of grassland. This indicates that villages at a higher elevation tend to have a lower level of landscape diversity and a lower percentage of cultivated land and grassland. Elevation is also found to be positively associated with the PLAND of forest, which suggests that villages with a higher elevation possibly have a higher proportion of forest. Slope is found to be positively correlated with PLAND of forest, and negatively correlated with all the other five metrics. This indicates that villages with a steeper slope tend to have a lower proportion of cultivated land and grassland but a higher proportion of forest. A steeper slope is also associated with a lower level of landscape diversity and fragmentation. Distance to the city center is not significantly correlated with any of the landscape metrics. This result is unexpected.

**Table 5.** Correlations between the landscape metrics (2020) and territorial variables.

| | SHDI | PD | ED | PLAND of Cultivated Land | PLAND of Forest | PLAND of Grassland |
|---|---|---|---|---|---|---|
| Elevation | −0.45 *** | −0.19 | −0.18 | −0.32 ** | 0.38 *** | −0.32 ** |
| Slope | −0.64 *** | −0.42 *** | −0.50 *** | −0.71 *** | 0.73 *** | −0.40 *** |
| Distance to the city center | −0.09 | −0.06 | −0.10 | −0.06 | 0.09 | −0.19 |

** Correlation is significant at the 0.01 level; *** Correlation is significant at the 0.001 level.

## 4. Discussion

Overall, this research presents a spatiotemporal analysis of land-use dynamics in Enshi Prefecture and landscape patterns in zones around 73 traditional villages. The analysis of land-use dynamics shows that Enshi Prefecture is dominated by forest (66.89% in 2020) and cultivated land (28.22% in 2020). Moreover, 82.53% of the land use in Enshi Prefecture experienced no changes between 2000 and 2020, and this echoes previous findings that agroforest ecosystems show relatively stable landscapes over time [24]. Mountainous areas also usually experience a slow land-use change [3]. The area of artificial surfaces tripled from 2010 to 2020. These increases were observed mostly around the eight main urban areas, indicating a noticeable urbanization process. While the proportion of water bodies increased, the area of wetland decreased dramatically. Wetland plays a vital role in ecological processes and functions (e.g., flood and drought prevention), and the decrease in the area of wetland might be caused by human activities, both directly and indirectly [27]. Continuous monitoring of wetland area change and a systematic protection of wetland in Enshi Prefecture are necessary. Forest was already the dominant landscape in 2000 (61.67%), and it continued increasing from 2000 to 2010 as a significant share of grassland was converted to forest. The share of cultivated land decreased slightly, with a 1.62% net loss. The increase in forests is possibly associated with the national and local policy of Grain for Green, which began in 1999. Enshi Prefecture is located in the key area in which the policy has been implemented [51]. An increase in forest cover helps maintain biodiversity, increase carbon storage, and provide economic values [52,53]. However, a study in the uplands of Vietnam found that, while the increase in plantation forests could help increase local household income and average carbon storage, food provision and the quality of natural forests decreased [52]. Therefore, in the implementation of policies related to forestation, local authorities should not simply pay attention to the quantity of forests, but also the quality. Furthermore, a recent meta-analysis found that forestation is associated with a decrease in annual river flow [53]. The tradeoffs between the ecosystem services provided by forests and other land covers need to be considered not only based on the national and regional policy context, but also local environment and communities [52,53].

With regard to the landscape patterns around the 73 traditional villages, four landscape metrics—PLAND, SHDI, PD, and ED–were calculated for a 3000 m buffer zone around each of the villages. The results of the PLAND reflect the composition of the landscape surrounding the villages, suggesting that the main land-use categories for most villages are forest and cultivated land. This is in accordance with the land-use patterns in the overall Enshi Prefecture. From 2000 to 2020, 72.6% of the 73 village buffer zones had an increasing share of forest, 75.3% had a decrease in cultivated land, and 61.6% had a decrease in grassland. The results of SHDI suggest that 67.1% of the villages had a decreased landscape diversity from 2000 to 2020, especially between 2000 and 2010. Since landscape diversity is related to several types of landscape services [18], local authorities should not only focus on a single land-use type (e.g., forest as driven by local policies) but also the diversity of the overall landscape. The computation of PD indicates that most villages (72.6%) had a decreased level of fragmentation, as the number of patches decreased within the analyzed units. Additionally, the value of ED decreased in 65.8% of the villages. The decrease in the level of fragmentation differs from previous research that focused on areas with more intensive human activities. It is considered that human activities usually result in a higher level of fragmentation and shape complexity [41].

The correlations between the six calculated metrics and the three territorial variables indicate that villages with different elevations and slopes might have different landscape patterns. While elevation and slope are positively associated with the proportion of forest, they are negatively associated with SHDI and the proportion of cultivated land and grassland. Slope is also negatively associated with PD and ED. Villages with a steeper slope might be more sensitive to natural risks [48]. Therefore, it is necessary to design appropriate land management strategies for villages with different elevations and slopes. No significant correlations were found between the landscape metrics and the villages' distance from urban centers, which is not in accordance with our assumptions. Previous studies have found that villages in peri-urban areas tend to show a higher level of fragmentation, whereas villages in remote rural areas tend to have a more stable landscape pattern [24,33]. In our research, although distances to urban centers show no correlation with the landscape pattern in 2020, this is possibly because most villages are located in remote rural areas. Enshi Prefecture's urbanization process is relatively slow compared with the more advanced districts of Hubei Province, thus the anthropogenic impacts on traditional villages are not yet evident. It should be noted that the increase in artificial surface was much faster in the 2010–2020 period than the 2000–2010 period, indicating a growing rate of urbanization. Therefore, although our results do not show dramatic changes in landscape patterns around the villages, attention should be paid to the future development of the study area with the increase in human activities. Destructive construction and the overconsumption of natural resources would negatively affect local ecosystem functions (e.g., erosion control and climate regulation) [18,20].

One contribution of this study is exploring the human–ecological structure of traditional villages by using a GIS-based buffer analysis. Our study adopts this approach to consider the wider landscape of many traditional villages, and it helps to understand and compare the environment of these historical settlements. The administrative boundaries of remote villages are often variable, changing over time, and unavailable. The buffer analysis can provide a unified analytical unit to consider the surrounding landscape of villages. Additionally, the analysis of landscape metrics can provide insights into how land cover, biodiversity, and fragmentation have changed around each traditional village.

This research has several limitations. First, due to the loss of some land-use data, we only analyzed the environment of 73 villages in Enshi Prefecture instead of all 81 traditional villages. Second, although the dataset used is our best available data in the study area with regard to time points and resolution, the 30 m grid may not be sensitive enough to detect small-scale rural buildings. Data with a higher resolution might produce more accurate results.

## 5. Conclusions

This research investigates an insufficiently studied area—the landscape dynamics of traditional Chinese villages. Based on a spatiotemporal analysis of LUCC and landscape metrics, we analyzed the surrounding environment of 73 traditional villages and the whole of Enshi Prefecture in which they are located. From 2000 to 2020, most villages have experienced an increased share of forest, a decreased share of cultivated land and grassland, and a decreased level of landscape diversity and fragmentation. Additionally, villages at a higher elevation or with a steeper slope tend to have a lower level of landscape diversity, a lower proportion of cultivated land and grassland, and a higher proportion of forest. The findings of this research contribute to our understanding of the landscape-pattern dynamics of Chinese national traditional villages. The protection of the natural environment of traditional villages is particularly urgent under the threat of human-related destruction in the urbanization processes [15]. For remote villages in ecologically vulnerable and less-developed areas, caution is needed in the tradeoff between environmental conservation and economic development. The findings suggest the need for a more integrated landscape conservation strategy for traditional villages and other vulnerable rural areas.

For future studies, it is necessary to further investigate and compare the landscape change of traditional villages in areas with different levels of development. It is possible that traditional villages in more developed areas would have a different evolution in landscape patterns. The influences of urbanization on traditional village landscape change need further investigation. Additionally, future studies are encouraged to explore the driving forces behind land-use change in traditional villages, for instance, demographic, socioeconomic, and transportation (e.g., road access) factors.

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