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Impacts of Different Tourism Models on Rural Ecosystem Service Value in Ziquejie Terraces

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Abstract: Villages are important components of agricultural heritage sites, and their tourism models significantly impact ecosystem service value (ESV). This study takes Zhenglong Village (culture and tourism integration), Ziquejie Village (farmstay type), and Jizhai Village (sightseeing type) with different tourism models in the Ziquejie Terraces heritage site as the research objects. Firstly, a single dynamic land use model and a land use transfer matrix were used to reveal rural land use changes driven by three different tourism models. Secondly, changes in ESV in the three villages were assessed with a valuation model. Finally, the welfare per unit area of villagers obtained from ecosystem services (ESs) was calculated. The results showed that: (1) From 2006 to 2022, the built-up area in the three villages gradually increased, primarily converting from farmland. Zhenglong Village experienced the smallest degree of change in both farmland and built-up areas. (2) The total ESV in Zhenglong Village increased by 0.35 times, the highest among the three villages. (3) Zhenglong Village saw the largest increase in welfare per unit area of villagers, from 82,551 CNY in 2006 to 111,785 CNY in 2022. Therefore, adopting a culture and tourism integration model in this heritage site is most conducive to conserving and enhancing the rural ESV, improving villagers' welfare, and promoting the sustainable development of villages and heritage sites.

Keywords: Ziquejie Terraces; rural ecosystem service value; tourism model; land use

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1. Introduction

With increasingly serious problems such as global warming and food crises [1], traditional agroecosystems have attracted widespread attention. These systems have the characteristics of sustainability, dynamic adaptability, and complexity [2] and can adapt well to climate and environmental changes. Despite their long history, traditional agroecosystems are facing multiple challenges, such as urban expansion, loss of rural labor, shrinking agricultural income, and farmland abandonment [3–6], affecting their inheritance and sustainable development. In view of the development difficulties faced by traditional agroecosystems, to better protect them, many countries and organizations have initiated the identification of agricultural heritage systems and proposed the dynamic protection of traditional agroecosystems. For example, the Food and Agriculture Organization of the United Nations (FAO) launched the Globally Important Agricultural Heritage Systems (GIAHS) [7], and China, South Korea, and Japan launched the Nationally Important Agricultural Heritage Systems (NIAHS) [8], among which GIAHS was the most influential. To date, China has 19 traditional agricultural systems recognized by the FAO as GIAHS, ranking first in the world in total. GIAHS are the result of harmonious coexistence between humans and nature and embody the wisdom of ancestors and the characteristics of agricultural culture [9]. They often have high aesthetic value and unique cultural heritage, so they are highly attractive to tourists. With the development of tourism, an increasing number of GIAHS have been developed for tourism and have become prestigious tourist attractions.

Villages are the constituent elements of GIAHS and the basic units of tourism activities. On the one hand, tourism development can enhance the social recognition of GIAHS, help people learn more about agricultural heritage systems [10], provide new employment opportunities for local villagers, and improve their livelihoods and living environments [11–13]. On the other hand, due to the construction of tourism reception facilities and the construction of tourism landscapes, farmland and woodland are occupied, which drives changes in village land use and thus affects local ecosystems [14–16]. However, there is still a lack of measurements of spatial and temporal changes in village land use caused by different tourism models, especially at long-history GIAHS sites. Furthermore, it is still unclear to what extent different tourism models drive changes in local ecosystems and whether these changes will affect sustainable development. To solve these problems, appropriate quantitative evaluation methods need to be adopted for exploration and research.

Ecosystem services (ESs) are the benefits people obtain from ecosystems [17]. The ecosystem service value (ESV) was used to quantify the economic value of ecosystem services using economic analysis with monetary values [18,19]. The assessment of ESV can evaluate the comprehensive value of an ecosystem and its degree of change [20], link the status of the ecosystem with human activities [21], and provide information for decisions about ecosystem management [22]. With the development of the concept of ESs, ESV and its evaluation have become important research fields in applied ecology [23] and have been widely used to evaluate the impact of human activities on ecosystems. Previous studies have primarily focused on the impact of different planting patterns on the ESV in agricultural heritage sites. Yuan et al. (2022) [24] compared the ESV of the integrated rice-fish-duck farming ecosystem and the rice monoculture system in Hani Terraces. Liu et al. (2020) [25] found the ESV of rice-fish coculture ecosystems in Ruyuan County was 37.9% higher than that in rice monoculture. Su et al. (2022) [26] analyzed the extra ESV in the Coastal Bench Terrace System relative to agricultural and aquatic ecosystems. However, few studies have linked tourism models with rural land use change and ESV change at GIAHS sites. Considering the continuous growth of tourism at GIAHS sites, it is necessary to study the rural land use change related to tourism models at GIAHS sites and its impact on ESV.

Ziquejie Terraces is located in Xinhua County, central Hunan Province, China, in the Fengjia Mountain section of the Xuefeng Mountain remnant. Formed over more than a thousand years by generations of Miao, Yao, Dong, Han, and other ethnic groups, the terraces are a historical relic that blend southern rice farming culture with mountain fishing and hunting traditions. The terraces are built according to the conditions of the mountains and are large in scale. Most of them are distributed between 500 and 1000 meters, with an average slope of approximately 30 degrees, and the steepest can reach more than 50 degrees. The slope is steep, the fields are small, and the shape is beautiful. This region enjoys the reputation of being called the "Terrace Kingdom" [27]. Due to its unique farming methods, pure natural gravity irrigation system, and profound cultural connotation, it has been successively rated as "China's Nationally Important Agricultural Heritage Systems" (China-NIAHS), "World Heritage Irrigation Structure" (WHIS), and "Globally Important Agricultural Heritage Systems" (GIAHS). Since opening to the public in 2006, the terraces have seen significant growth in tourism, with peak season attracting over 50,000 visitors daily. In the process of tourism development, villages in the heritage site have developed different tourism models.

Here, three villages with different tourism models in the core area of Ziquejie Terraces were selected as the research area. Based on high-resolution remote sensing images combined with field research, the land use changes in these villages since 2006 were interpreted and measured, and the impacts of the tourism models on ESV were subsequently analyzed. The aims of the study were as follows: (i) measure rural land use changes driven by different tourism models; (ii) assess changes in rural ESV under the influence of different

tourism models; and (iii) analyze the impact of different tourism models on the rural ESV. Finally, policy implications were proposed based on the main findings.

2. Materials and Methods

2.1. Study Area

2.1.1. Geographic Location

The study subjects, Zhenglong Village, Ziquejie Village, and Jizhai Village, are located in the core area of Ziquejie Terraces (Figure 1). The three villages are all located in mountainous areas and belong to the mid-subtropical monsoon climate zone, which has a unique climate. The average annual temperature is 15 °C, the average annual precipitation is 1640 mm, and the frost-free period is approximately 235 days. The soil is red soil and yellow soil with differentiated development of granite. It is rich in organic matter and is suitable for the growth of crops. The natural and ecological environments of the three villages are similar, with large areas of farmland and woodland, and the farmland is mainly planted with rice. In recent years, the scale of tourism has continued to expand, and its position in local social and economic development has become increasingly important.

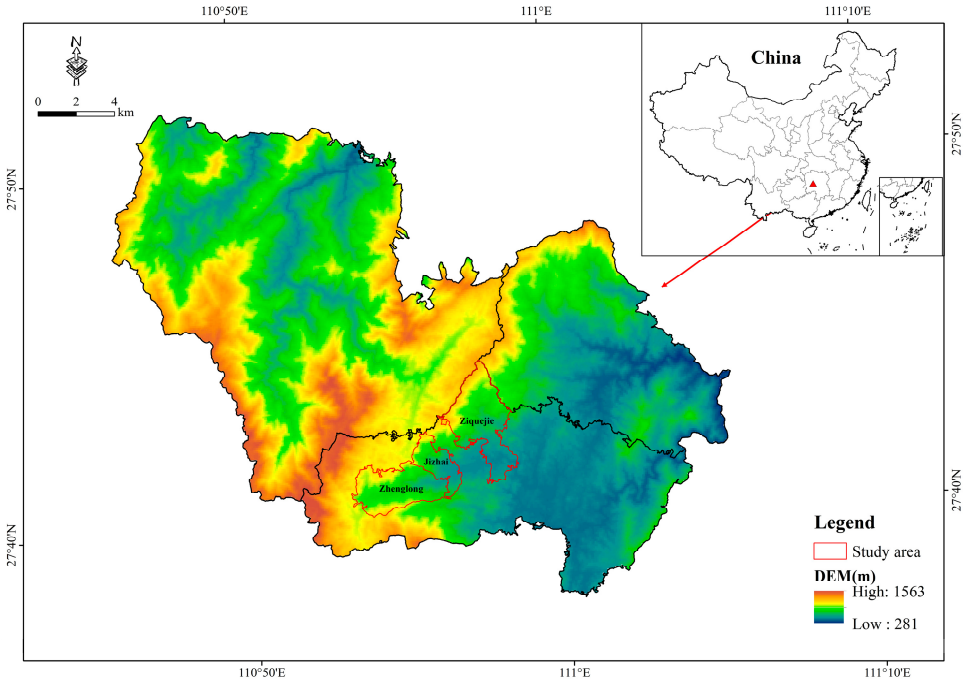

Figure 1. Location of the study area.

2.1.2. Tourism Models

The rural tourism model is a summary of the presentation form and management mechanism of tourism carried out by operators in specific rural areas [28]. Previous studies have proposed different models of rural tourism from various perspectives. Based on the content of the experience, Li categorized Japanese rural tourism into sightseeing, leisure, and rural cultural tourism models [29]. Based on the management model, Li et al. divided rural tourism into individual farm type, farmer cooperative type, and company-farmer type [30]. From the perspective of tourism projects, Wang et al. classified rural tourism into sightseeing, farmstay, business conference, leisure vacation, picking and tasting, etc. [31]. In line with the tourism projects and the content of tourist experiences, the three villages have formed different tourism models, such as cultural and tourism integration, farmstay type, and sightseeing type (Table 1).

Table 1. Tourism models of Zhenglong, Ziquejie, and Jizhai Villages.

	Zhenglong	**Ziquejie**	**Jizhai**
Tourism models	Cultural and tourism integration	Farmstay type	Sightseeing type
Main tourism projects	Sightseeing, photography, tourism reception, and cultural experience	Sightseeing, photography, tourism reception	Sightseeing, photography
Experience content	Enjoy the terraced scenery and experience Meishan culture	Enjoy the terraced scenery, farm accommodation	Enjoy the terraced scenery
Participation degree of villagers	High	Medium	Low
Degree of cultural inheritance	High	Low	Low
Degree of cultural resources utilization	High	Low	Low

In 2022, Zhenglong Village had a total area of 905.77 ha and a total population of 2660. It is a well-protected traditional village in Ziquejie Terraces with a history of more than 200 years. In 2014, it was included in the third batch of traditional Chinese villages. Zhenglong Village began to develop tourism in 2010 and currently has 28 homestays and farmstays. The terraces in the village are divided into northern and southern terraces. More than 200 residential houses with the traditional stilt-style board house architectural style of Ziquejie are freely laid out along the contour lines, following the mountains and intertwining with each other, and they combine with the terraces to form beautiful pastoral scenery. Combined with its unique Meishan culture, existing residential buildings have been used to build projects such as Jiufang Shibapu and a farming museum, and special activities such as the "Zhenglong Ancient Village Jiuqu Huilong Banquet" have been carried out. Under the leadership of the village committee and rural elites, Zhenglong Village has developed a cultural and tourism integration model. This model fully explores and utilizes local cultural resources, incorporating cultural elements into tourism products and services. It creates diverse cultural experiences and products, meets tourists' needs for cultural engagement, enhances the added value and attractiveness of tourism, and promotes cultural inheritance and dissemination [32].

In 2022, Ziquejie Village had a total area of 1143.21 ha and a total population of 3980. The villagers of Ziquejie Village are the first major group to perform farmstays and tourism catering in a heritage site. Since the first farmstay in Ziquejie Terraces, Yongxing Farmstay, opened in 2006, the number of tourism reception facilities has gradually increased. There are currently 47 homestays and farmstays, making it the village with the most tourism reception facilities in Ziquejie Terraces. There are 3 terraced viewing platforms within Ziquejie Village that occupy the best position to appreciate the beauty of Ziquejie Terraces and the art of farming at close range. Tourists can enjoy the terraced landscape from the hotel. Under the leadership and guidance of rural elites, Ziquejie Village has developed a farmstay model. In this model, farmers utilize their own courtyards to offer tourists dining, accommodation, and terraced sightseeing activities.

In 2022, Jizhai Village had a total area of 395.29 ha and a total population of 1762. The terraces in the village stretch on the hillside, with a large scale and a variety of scenery. It has the production base of Ziquejie Tribute Rice, a Chinese agro-product geographical indications product. There is a terraced viewing platform in the village, the Gongmiling viewing platform, which is a good place to watch the terraced landscape and take photos of the sunrise and the sea of clouds. Jizhai Village has relatively few tourist reception facilities, with only a few scattered farmstays and tourist accommodations. Additionally, few farmers participate in tourism development, and the tourism projects primarily focus on viewing terraced landscapes and photography. The tourism model is sightseeing type.

2.2. Data Sources

Since Ziquejie Terraces was designated as part of the national natural and cultural heritage sites in 2006, the Ziquejie Terraces Scenic Area Management Office was established, and the first farmstay in Ziquejie opened, marking the beginning of tourism development in the area. After 2014, with the successful recognition of Ziquejie Terraces as a World Heritage site (WHIS and GIAHS) and the opening of the Ziquejie Terraces National Highway Intersection, the site's popularity further increased, and tourism development entered a new phase. Consequently, research data for Zhenglong Village, Ziquejie Village, and Jizhai Village from 2006, 2014, and 2022 were collected, corresponding to two stages of development (2006–2014 and 2014–2022). The data used in this study are shown in Table 2.

Table 2. Study data sources.

Data Type	Data Description	Data Sources
Land use data	High-resolution satellite images with a resolution of 5 m	Google Earth
Meteorological data	The number of hot days in summer The average daily water evaporation in the farmland Mean annual precipitation Annual average temperature	Meteorological Department of Xinhua County
Soil data	SOM, N, P, K contents in the soil Soil bulk density	The Third Land Survey of Xinhua County
	Erosion modulus of wasteland Actual erosion modulus	Water Resources Department of Xinhua County
Other ecological parameters	The average emission flux of CH_4, N_2O, CO_2 in farmland The soil water infiltration rate in farmland The carbon content of rice root system and straw The moisture content of rice	Agricultural Technology Station of Shuiche Town
	The number of days of standing water period of rice The number of days of growth period of rice The average ridge height of rice field The depth of standing water in rice field	Field survey
	The average fluxes of SO_2, NOx, HF, and dust absorbed by the farmland, woodland, and water The amount of nutrient elements from forest litter returned to forest land The transpiration coefficient of woodland	Published literature [33–36]
Statistical data	The purification cost of SO_2, NOx, HF, and dust The cost of industrial oxygen production	Ecology and Environment Department of Hunan (http://sthjt.hunan.gov.cn (accessed on 2 May 2024))
	The Swedish carbon tax rate	http://www.tanjiaoyi.com/ (accessed on 2 May 2024)
	The unit price of reservoir engineering fee usage	Water Resources Department of Xinhua County
	The yield and price of agricultural and forestry products The price of coal and fertilizer The pesticide costs The number of visitors Total tourism revenue	Field survey

2.3. Land Use Change Calculation

The satellite images were subjected to geometric correction, coordinate registration, image fusion, visual interpretation, and field survey correction to obtain three phases of land use data (Figure 2). According to the land use classification standards of the Chinese Academy of Sciences and combined with the characteristics of village land use, the land use types of the three villages were divided into four categories: farmland, woodland, built-up area, and water area. Based on three periods of land use data, a single dynamic land use model [37] was used to reveal the changes in the area of a certain land use type within a certain time range in the study area. Its mathematical expression is:

$$K = \frac{Ub - Ua}{Ua} \times \frac{1}{T} \times 100\% \quad (1)$$

where K is the dynamic degree of a certain land use type during the study period, Ua and Ub are the areas of a certain land use type at the beginning and end of the study period, respectively, and T is the study period.

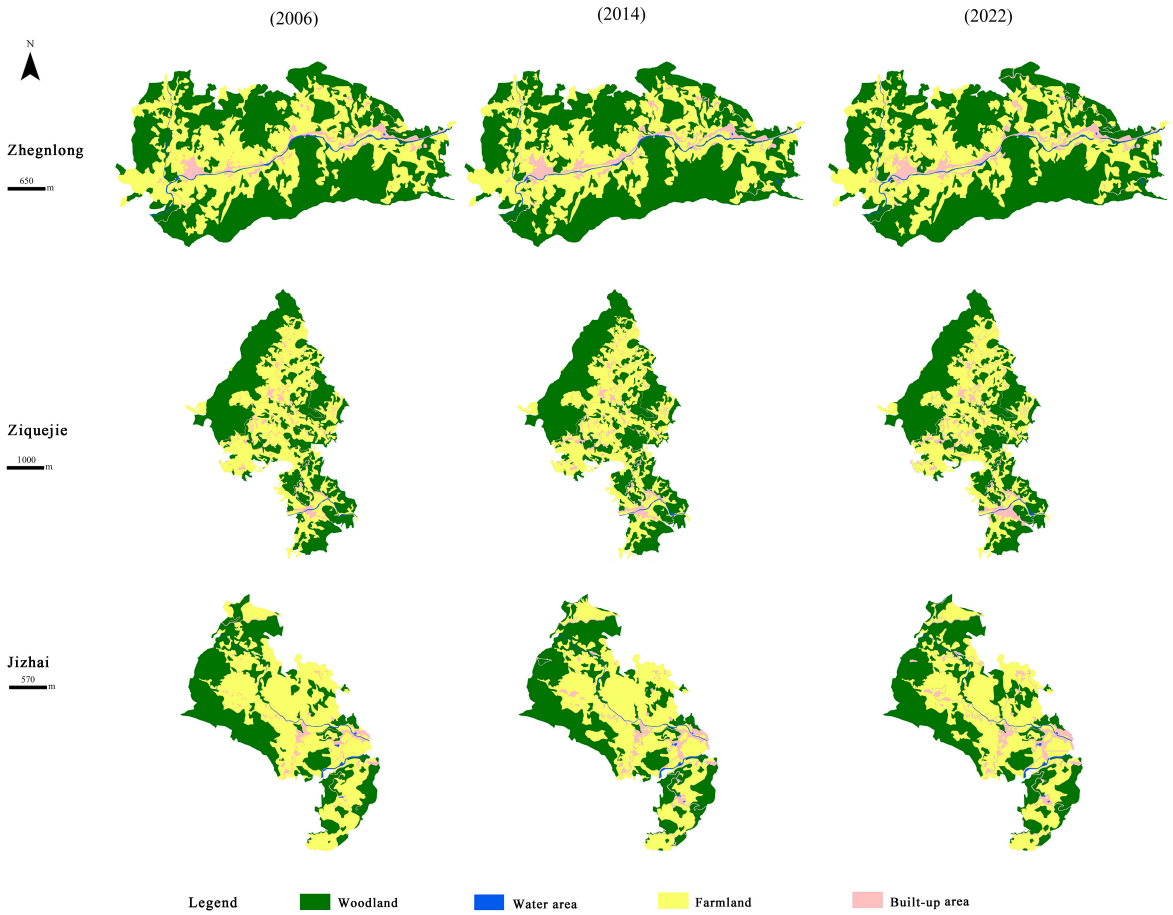

Figure 2. Land use maps of Zhenglong, Ziquejie, and Jizhai Villages in 2006, 2014, and 2022.

The land use transfer matrix [38] was used to reveal the transfer direction and nature among the land use types in Zhenglong Village, Ziquejie Village, and Jizhai Village. Its mathematical expression is:

$$S_{ij} = \begin{vmatrix} S_{11} & S_{12} \dots & S_{1n} \\ S_{21} & S_{22} \dots & S_{2n} \\ \dots & \dots & \dots \\ S_{n1} & S_{n2} & \dots & S_{nn} \end{vmatrix} \quad (2)$$

where S is the area of land type, n is the total number of land types, and S_{ij} represents the area of type i land converted to type j land from the beginning to the end of the study period.

The spatial processing function of ArcGIS pro 3.0 was used to conduct an overlay analysis of the land use status vector maps of the three villages in 2006, 2014, and 2022, and the land use transfer matrices of the three villages in 2006–2014, 2014–2022, and 2006–2022 were obtained.

2.4. Ecosystem Service Value Evaluation Method

The Common International Classification of Ecosystem Services (CICES) [39], developed by the European Environment Agency, employs widely recognized ecosystem service classifications and environmental accounting frameworks to ensure its rationality. The latest classification of ecosystem services aims to unify and standardize the description and evaluation of ESs internationally. Thus, based on the characteristics of the rural ecosystem in the Ziquejie Terraces heritage site, this study used the latest CICES5.1 version (2018) to construct an assessment model to calculate the rural ESV of Ziquejie Terraces. In this study, built-up area was assigned an ESV of 0, referencing previous studies [40]. According to the CICES classification system, ESs are divided into three sections: provisioning, regulation and maintenance, and cultural services. The ES classification and valuation methods are shown in Table 3. The calculation formulas, parameter values, etc., are provided in Tables S1–S3.

Table 3. The ES classification and valuation methods of Ziquejie Terraces (according to CICES V5.1).

Section	Division	ES	Farmland Ecosystem	Woodland Ecosystem	Water Ecosystem	Evaluation Method
Provisioning	Biomass	Providing primary product	√	√		Market price method
	Water	Surface water for drinking			√	Market price method
Regulation & Maintenance	Transformation of biochemical or physical inputs to ecosystems	Air purification	√	√	√	Protection cost method
		Water purification			√	Protection cost method
	Regulation of physical, chemical, and biological conditions	Control of erosion rates	√	√		Opportunity cost method and shadow project method
		Water resources storage			√	Shadow project method
		Groundwater recharge	√	√		Shadow project method
		Flood control	√		√	Shadow project method
		Increase of fauna diversity and micro-organisms	√	√	√	Ecological value method, Shannon–Wiener index evaluation method
		Reducing pesticides and herbicides	√			Substitute cost method
		Maintaining soil nutrients	√	√		Substitute cost method
		Regulation of chemical composition of atmosphere	√	√	√	Carbon tax method and industrial oxygen method
		Temperature regulation	√	√	√	Substitute cost methods and outcome parameter method

Table 3. *Cont.*

Section	Division	ES	Farmland Ecosystem	Woodland Ecosystem	Water Ecosystem	Evaluation Method
Cultural	Direct, in situ, and outdoor interactions with living systems that depend on presence in the environmental setting	Development of tourism	√			Travel cost method
		Cultural inheritance	√			Substitute cost method

3. Results

3.1. Land Use Changes

3.1.1. Land Use Dynamic Analysis

As shown in Table 4, from 2006 to 2022, the most dynamic land use type in Zhenglong Village was the built-up area, accounting for 2.06%, and the built-up area increased gradually. From 2014 to 2022, the growth rate of the built-up area slowed, and the dynamic level was significantly lower than that in the previous period. From 2006 to 2022, the area of farmland and water area decreased gradually, while the area of woodland increased gradually, with the smallest dynamic change.

Table 4. Land use dynamic (%) in Zhenglong, Ziquejie, and Jizhai Villages, 2006–2022.

Land Types	Zhenglong Village			Ziquejie Village			Jizhai Village		
	2006–2014	2014–2022	2006–2022	2006–2014	2014–2022	2006–2022	2006–2014	2014–2022	2006–2022
Farmland	−0.51	−0.20	−0.35	−0.70	−0.16	−0.43	−0.51	−0.74	−0.61
Woodland	0.19	0.06	0.13	0.37	−0.11	0.13	0.1	0.65	0.38
Water area	−0.14	−0.75	−0.44	1.14	−0.37	0.37	2.4	0.00	1.21
Built-up area	2.73	1.14	2.06	2.71	2.42	2.83	5.72	2.02	4.33

From 2006 to 2022, the most dynamic land use type in Ziquejie Village was the built-up area, accounting for 2.83%, and the built-up area increased gradually. From 2014 to 2022, the increase in the built-up area slowed, and the dynamic level decreased slightly compared with that in the previous period. From 2006 to 2022, farmland decreased gradually, and the decrease from 2014 to 2022 slowed down from the previous period. The woodland area and water area first increased and then decreased.

From 2006 to 2022, the dynamic level of the built-up area in Jizhai Village was the highest, at 4.33%. The built-up area increased gradually. From 2014 to 2022, the increase in the built-up area slowed, and the dynamic level decreased significantly compared with that in the previous period. From 2006 to 2022, farmland decreased gradually, and the decrease in 2014–2022 increased compared with that in 2006–2014.

3.1.2. Land Use Transfer Matrix Analysis

From 2006 to 2022, the total land use conversion in Ziquejie Village was the largest at 649,316 m^2, while the total land use conversion in Zhenglong Village and Jizhai Village was 627,241 m^2 and 450,700 m^2, respectively. Among all land types in the three villages, the outflow area of farmland was the largest and was mainly converted to woodland and built-up area. The farmland outflow area of Ziquejie Village was the largest at 415,709 m^2, while the farmland outflow area of Zhenglong Village and Jizhai Village was 322,048 m^2 and 263,463 m^2, respectively (Figure 3, Table S4). In the three villages, the increase in built-up area mainly came from the conversion of farmland, accounting for 82.85%, 78.13%, and 92.6%, respectively. From the perspective of the time period, the total land use conversion in the three villages during 2014–2022 was smaller than that during 2006–2014 (Figure 4, Tables S5 and S6). Since 2014, the local protection of Ziquejie Terraces has been strengthened, which has slowed down the conversion intensity among different land types.

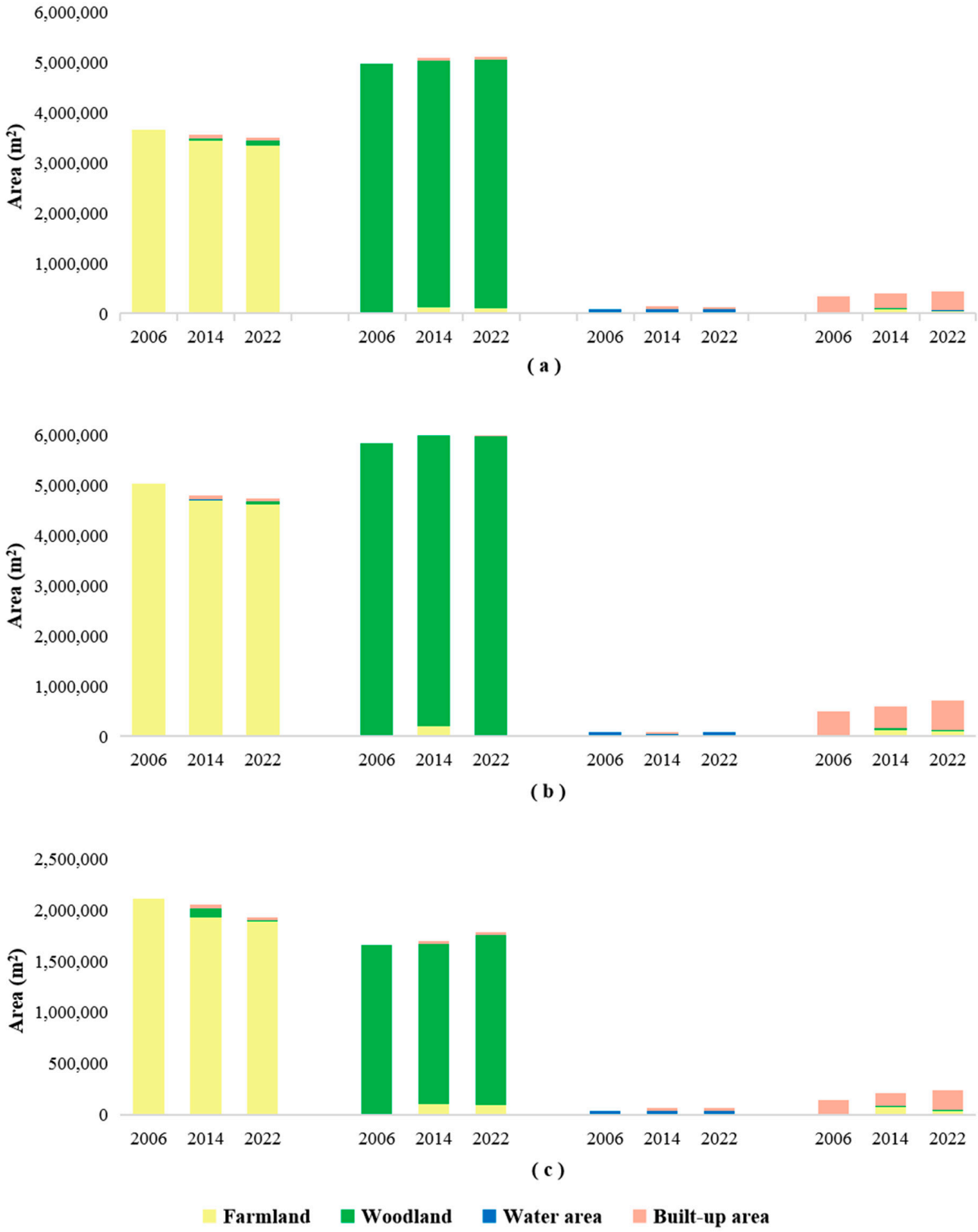

Figure 3. Land use types in 2006, 2014, and 2022. (**a**) Zhenglong, (**b**) Ziquejie, (**c**) Jizhai.

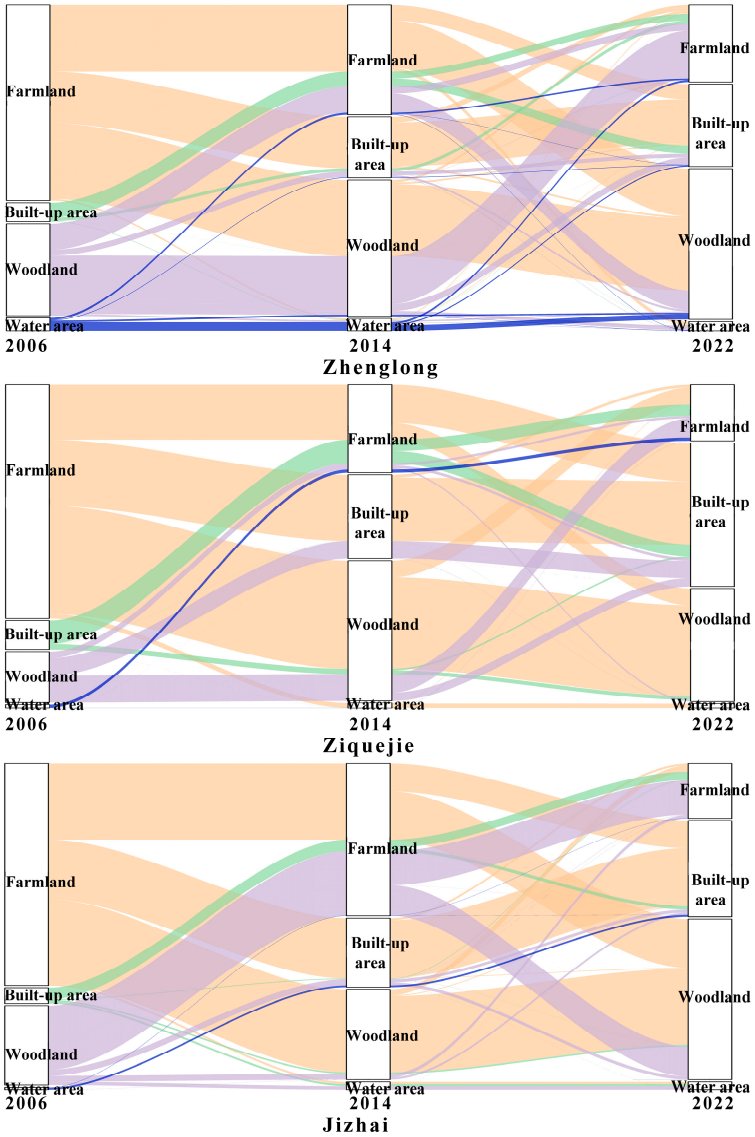

Figure 4. Sankey diagram of land use conversion in Zhenglong, Ziquejie, and Jizhai Villages, 2006–2022.

3.2. Total ESV Changes

From 2006 to 2022, the total ESV in Zhenglong, Ziquejie, and Jizhai Villages all showed a trend of decreasing first and then increasing (Figure 5). Because after 2014, Ziquejie Terraces was successively awarded two titles: WHIS and GIAHS. With the increased protection of Ziquejie Terraces, ESs have been conserved. At the same time, with the increase in popularity, the ecological value of the terraces has been brought into play to a greater extent. From 2006 to 2022, the total ESV in Zhenglong Village increased by 0.35 times, from 74.77 million CNY to 101.25 million CNY, higher than the 0.31 times for Ziquejie Village and 0.30 times for Jizhai Village. In terms of farmland ecosystem, compared with that in 2006, the ESV in Zhenglong Village in 2022 increased by 0.82 times, from 32.48 million CNY to 59.16 million CNY, which was higher than the 0.74 times for Ziquejie Village and 0.64 times for Jizhai Village. Due to the cultural and tourism integration model adopted by Zhenglong Village, which integrates sightseeing photography, tourism reception, and cultural experience, farmland ESs are utilized to a high degree, thus giving full play to the farmland ESV. In terms of woodland ecosystem, compared with 2006, the ESV of Zhenglong Village increased slightly in 2022, while the ESV of Ziquejie Village and Jizhai Village decreased slightly. In terms of water ecosystem, the ESV of the three villages

in 2022 showed a decrease compared with 2006. In recent years, the focus of protection and development has been on the terraced ecosystem, with less attention paid to forest area and water area, resulting in a decrease in the ESV of woodland area and water area.

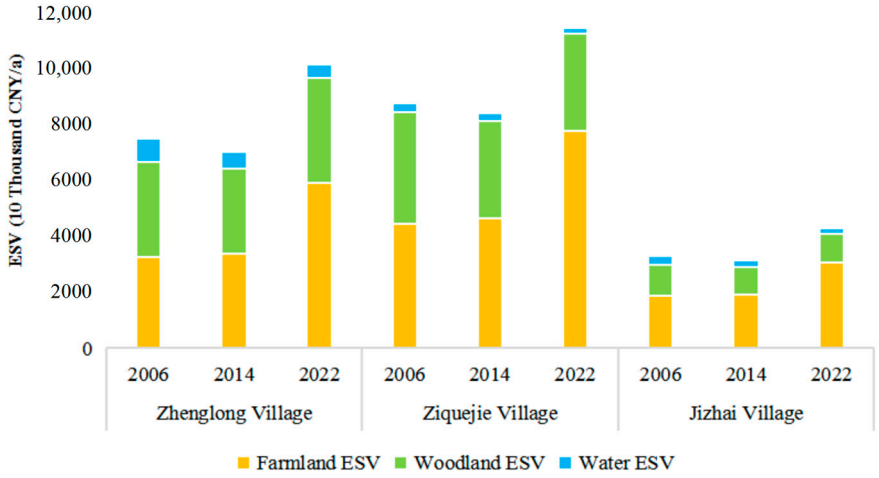

Figure 5. Changes in ESV in Zhenglong, Ziquejie, and Jizhai Villages, 2006–2022.

3.3. Single ESV Changes

For the three villages, the proportion of regulation and maintenance service is the largest. The main single ESs are groundwater recharge, increase in fauna diversity, and micro-organism and temperature regulation, all of which fall under regulation and maintenance services. All of these indicate that regulation and maintenance services play an important role in the ESs of the three villages. From 2006 to 2022, there were significant changes in the 15 single ESV in the three villages. The values of control of erosion rates, water resources storage, groundwater recharge, flood control, maintaining soil nutrients, and regulation of the chemical composition of the atmosphere are all decreasing. Therefore, with the development of tourism, the quality of some ESs has declined. The increase in value of providing primary products is mainly due to rising rice prices. Among the three villages, Zhenglong Village saw the most significant increase in the value of providing primary products, as tourism development not only boosted the value of agricultural products but also increased the value of forest products. The value of forest products in the other two villages increased less. The development of tourism value in Zhenglong Village increased by 2.84 million CNY, higher than the other two villages. Compared to Ziquejie Village and Jizhai Village, Zhenglong Village places more emphasis on the protection and inheritance of traditional culture, resulting in an increase of 388,900 CNY for its cultural heritage value, while the other two villages saw no increase.

3.4. Welfare of Villagers from ESs

To more comprehensively analyze the impact of different tourism models on rural ESV, the welfare of villagers per unit area obtained from ESs in each village (i.e., the ESV per unit area) was statistically calculated. From 2006 to 2022, the welfare per unit area obtained from ESs in Zhenglong Village, Ziquejie Village, and Jizhai Village all increased. Zhenglong Village increased from 82,550 CNY to 111,785 CNY, Ziquejie Village increased from 76,695 CNY to 100,091 CNY, and Jizhai Village increased from 83,241 CNY to 108,257 CNY, an increase of 29,235 CNY, 23,396 CNY, and 25,016 CNY, respectively (Table 5). Zhenglong Village experienced the largest increase in welfare per unit area from ESs.

Table 5. Changes in single ESV (10 thousand CNY/a) in Zhenglong, Ziquejie, and Jizhai Villages, 2006–2022.

Section	ES	Zhenglong Village			Ziquejie Village			Jizhai Village		
		2006	2014	2022	2006	2014	2022	2006	2014	2022
Provisioning	Providing primary product	268.34	683.57	717.40	366.91	922.18	857.17	154.08	390.97	340.23
	Surface water for drinking	15.10	17.54	17.42	22.59	26.24	26.07	10.00	11.62	11.54
Regulation & Maintenance	Air purification	256.85	183.39	581.33	304.01	219.86	687.57	87.65	62.10	205.16
	Water purification	0.10	0.10	0.08	0.04	0.04	0.04	0.04	0.04	0.04
	Control of erosion rates	377.51	317.00	300.91	397.43	339.51	321.41	137.97	114.64	109.88
	Water resources storage	34.45	30.90	26.71	12.72	12.59	11.23	12.12	13.12	12.06
	Groundwater recharge	1806.50	1578.90	1430.21	2463.03	2120.08	1923.86	1011.63	882.41	767.08
	Flood control	364.44	317.98	286.54	473.08	406.37	368.49	203.86	179.58	155.90
	Increase in fauna diversity and micro-organisms	1733.62	1826.87	3168.17	2077.54	2079.39	3487.99	629.55	639.50	1248.59
	Reducing pesticides and herbicides	15.39	18.57	17.29	21.19	25.15	23.50	8.88	10.71	9.54
	Maintaining soil nutrients	91.08	72.30	68.92	119.26	93.66	88.29	45.01	35.16	31.96
	Gas regulation	793.53	639.97	737.36	875.98	736.84	408.81	195.74	172.01	101.27
	Climate regulation	1720.24	1273.77	2450.03	1590.77	1245.58	2933.82	793.92	620.54	1269.34
Cultural	Development of tourism	0.00	20.95	283.94	43.22	150.82	304.26	0.00	14.08	16.67
	Cultural inheritance	0.00	12.32	38.89	0.00	0.00	0.00	0.00	0.00	0.00
	Total	7477.15	6994.13	10,125.21	8767.77	8378.31	11,442.50	3290.44	3146.48	4279.27
	Per unit area	8.26	7.72	11.18	7.67	7.33	10.01	8.32	7.96	10.83

The welfare that villagers obtained from ESs includes direct economic welfare and indirect environmental welfare. Providing primary products and development of tourism, which are two ESs, can directly generate economic value and increase villagers' income. Together, these factors are called direct economic welfare and can better reflect the utilization of ESV. From 2006 to 2022, the economic welfare per unit area of Zhenglong Village increased by 8092 CNY, which was the largest among the three villages. In terms of time periods, the economic welfare per unit area increased by 4815 CNY from 2006 to 2014. This stage was mainly due to the increase in economic benefits brought about by the provision of primary products. It increased by 3277 CNY from 2014 to 2022. At this stage, with the further establishment of its cultural and tourism integrated model, the increase in tourism income exceeded the provision of primary products and was also the largest among the three villages. From 2006 to 2022, the economic welfare per unit area of Ziquejie Village increased by 6571 CNY. It increased by 5798 CNY from 2006 to 2014 and by 773 CNY from 2014 to 2022. From 2006 to 2022, the economic welfare per unit area of Jizhai Village increased by 5131 CNY, which was the lowest among the three villages. The economic welfare per unit area increased by 6349 CNY from 2006 to 2014 but decreased by 1218 CNY from 2014 to 2022 (Figure 6), mainly due to the increase in price after Ziquejie Tribute Rice was recognized as a Chinese agro-product geographical indications product in 2010, which greatly increased the value of primary products. In the later period, the tourism model was sightseeing type, the tourism projects were relatively simple, and tourism revenue increased less, which is insufficient to compensate for the decrease in the output value of primary products, resulting in a decrease in economic welfare per unit area.

Although ESs, such as air purification, groundwater recharge, and flood control, cannot directly generate economic value, they are important prerequisites and foundations for ensuring sustainable development and environmental health [41], as well as the basis for using ESs to generate economic value. Together, these factors are called indirect environmental welfare and can better reflect the conservation status of ESV. From 2006 to 2022, the environmental welfare per unit area of the three villages all showed a trend of decreasing first and then increasing (Figure 6). In the early stage of tourism development, the ecological environment of the three villages suffered a certain degree of destruction. After 2014, with the strengthening of the protection of Ziquejie Terraces, the environmental welfare per unit area increased. Compared with 2006, the environmental welfare per unit area of Zhenglong, Ziquejie, and Jizhai Villages in 2022 increased by 21,142 CNY, 16,825 CNY, and 19,885 CNY, respectively. Zhenglong Village had the largest increase in environmental

welfare per unit area, mainly because its farmland and built-up area have the smallest dynamic levels, so the environmental protection situation is good.

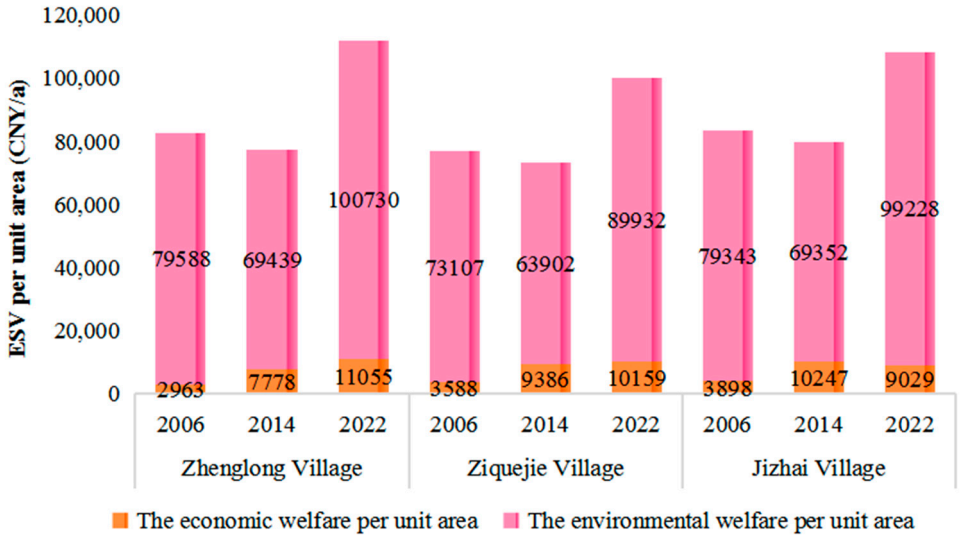

Figure 6. The welfare of villagers per unit area in Zhenglong, Ziquejie, and Jizhai Villages, 2006–2022.

4. Discussion

4.1. The Impact of Tourism Model on Rural ESV

Tourism development has a vital impact on village economies and ecosystems [42]. Understanding the relationship between heritage site tourism models and rural ESV is an effective way to guide the sound tourism management of GIAHS sites. The impact of the tourism model on rural ESV is mainly reflected in two aspects: on the one hand, the tourism model drives changes in the type and intensity of rural land use, using land use as an intermediary to affect ESV; this is consistent with the study of Ding et al., 2016 [43], who found that the economic development model uses land use as the medium to affect the ESV. On the other hand, different tourism models form different ways of utilizing ESV, thereby affecting the utilization efficiency and conservation of ESV. The level of human welfare depends on the provisioning, regulation and maintenance, and cultural services provided by ecosystems. The conservation and utilization of ESV will also affect the income and welfare of local people. The conservation and utilization of ESV also affect the income and welfare of local people, as also demonstrated by Wang et al., 2017 [44]. In contrast, villagers will exert different impacts on the structure, process, and function of ESs by changing their work style and lifestyle according to changes in their own income and welfare (Figure 7).

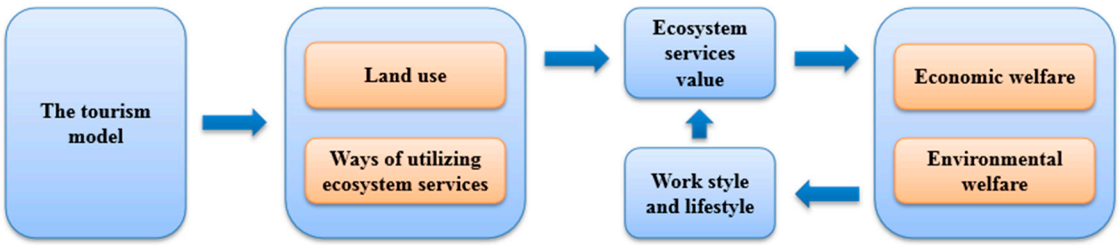

Figure 7. The relationship between tourism model, rural ESV, and villagers' welfare.

From 2006 to 2022, with the increase in the number of tourists, the built-up area used for tourism services in the three villages showed a growth trend, and most of it was converted from farmland. This is in line with other findings elsewhere [42,45]. In comparison, the dynamic degrees of farmland and built-up area in Zhenglong Village are the smallest, at −0.35% and 2.06%, respectively. The dynamic degrees of farmland and

built-up areas in Jizhai Village are the largest, at −0.61% and 4.33%, respectively. Ziquejie Village is in the middle. Under the influence of the cultural and tourism integration model, the villagers of Zhenglong Village have a deeper understanding of the traditional farming culture of Ziquejie Terraces and are paying more attention to the protection of terraces in the process of tourism development. Therefore, Zhenglong Village has the lowest reduction in farmland, the largest increase in environmental welfare per unit area, and the best ES conservation.

Since Ziquejie Terraces was developed for tourism in 2006, the three villages have relied on Ziquejie Terraces to develop tourism, and their tourism income has gradually increased. The tourism income of Zhenglong Village increased from 0 CNY to 2.84 million CNY, the largest growth rate. Especially after 2014, with the further establishment of its cultural and tourism integration model, the increase in tourism income from 2014 to 2022 accounted for 92.62% of the total increase. The tourism income of Ziquejie Village increased from 0.43 million CNY to 3.04 million CNY, the second-largest growth rate. The tourism income of Jizhai Village increased from 0 CNY to 0.17 million CNY, the lowest growth rate. Zhenglong Village relies on the unique farming culture, Meishan culture, and architectural culture of Ziquejie Terraces to gradually form a cultural and tourism integration model, which has improved the utilization efficiency of ESV and fully utilized the driving force of tourists to transform ESV into tourism commodities.

In 2022, the ESV per unit area, economic welfare per unit area, and environmental welfare per unit area of Zhenglong Village were 111,785 CNY, 11,055 CNY, and 100,730 CNY, respectively, which were higher than Ziquejie Village and Jizhai Village. From 2006 to 2022, their increase was also higher than the other two villages. Using the resource advantages of the agricultural heritage system to develop a cultural and tourism integration model can not only improve the utilization efficiency and marketization ability of ESV, increase industrial income, and make direct contributions to local economic development but also enhance the protection of local ecosystems by residents, mitigate the reduction of terraces, and improve their ESV. This result was similar to previous studies of the Hani Terraces [46]. This approach is an important way to promote the coordinated development of the environment and economy [47,48].

4.2. Policy Implications

Our research showed that tourism models have an important impact on rural ESV at agricultural heritage sites, which provides the following three main implications for ecosystem management and decision-making at Ziquejie Terraces heritage sites.

First, the protection of Ziquejie Terraces should be strengthened. The terraces are the cornerstone of the sustainable development of Ziquejie Terraces and are also the main feature that distinguishes it from other tourist destinations. However, through the interpretation of satellite images, land use data analysis, and field surveys of Zhenglong Village, Ziquejie Village, and Jizhai Village, it was found that the terrace area has been reduced in all three villages. According to the land use conversion situation, some terraces have been converted into built-up area for the construction of tourist facilities, while some terraces have gradually been converted into woodland and other land due to low returns from farming. In view of the phenomenon of terraces being occupied by construction projects, strict implementation of existing terrace protection policies and severe punitive measures against units and individuals who occupy terraces are recommended [49]. For terraces that have been abandoned due to low farming returns, further compensation should be increased on the basis of existing farming compensation to curb the phenomenon of abandoned farming on terraces. Forests and water areas are important components of Ziquejie Terraces and should be protected to prevent further destruction. While being protected, they can also be reasonably utilized to maximize their ecological value. Moreover, a long-term environmental change monitoring system should be established to understand and monitor changes in terraces in a timely manner.

Second, a tourism model that integrates culture and tourism should be promoted. Utilizing the beautiful and spectacular terraced landscape and long-standing cultural heritage to develop tourism has become one of the main ways for villagers in Ziquejie Terraces to generate income. Our study shows that the cultural and tourism integration model has the most significant effect on increasing tourism revenue. However, field research has shown that the tourism development of most villages in Ziquejie Terraces has very little exploration or utilization of local farming culture and Meishan culture. For example, Ziquejie Village, which was the first to develop tourism, is still mainly focused on terrace sightseeing and tourism reception. There is a single tourism product, and there are very few tourism projects for tourists to experience. Tourists generally stay for a short time, which seriously restricts the increase in tourism income. Agricultural production activities with more economic value are often the first choice of stakeholders [50]. Therefore, vigorously promoting a cultural and tourism integration model in Ziquejie Terraces is recommended to maximize the local ESV.

Finally, the inheritance and utilization of traditional culture should be promoted. The traditional culture of Ziquejie Terraces has distinctive features, that is, lifestyle, residential construction, village site selection, cultural beliefs, etc., and they all emphasize maintaining a high degree of harmony with nature, embodying the traditional environmental view of "harmony between man and nature". Cultural motivation is to ensure the harmony between man and land, ecological balance, and sustainable development of Ziquejie Terraces. Ziquejie Terraces is rich in traditional cultural resources, such as farming culture, Meishan culture, religious beliefs, residential architecture, and food customs, and has local characteristics. However, except for food culture and martial arts, other traditional cultures have a low degree of inheritance and are even endangered. For example, in the process of tourism development, some villagers considered only short-term benefits and built houses at will. The new houses have completely changed the style of traditional houses, and the architectural features have basically disappeared, destroying the agricultural cultural landscape of Ziquejie Terraces, which consists of four major elements: terraces, vegetation, water systems, and houses. The utilization of traditional cultural resources, an important tourism attraction, is also very low. Among the three villages, except for Zhenglong Village, there are almost no tourism products with traditional cultural experience, resulting in a low utilization rate of ESV. Therefore, we can promote the inheritance and utilization of traditional culture by establishing a traditional cultural database, conducting cultural heritage knowledge training, and innovating and developing cultural tourism products to achieve a win–win situation for the conservation and utilization of ESs.

4.3. Research Limitations

Exploring the impact of tourism on ecosystems is essential for the sustainable development of agricultural heritage sites. Previous studies have predominantly examined the impact of tourism on heritage sites [42,51]. This study, however, explores how various tourism models affect the ecosystem service value (ESV) of villages, which are fundamental elements of heritage sites. The research perspective has some innovation, but there are still certain limitations that need to be addressed in future research. First, the causal relationship between tourism models and rural ESV requires further analysis. Second, methods for accurately assessing rural ESV need to be improved. With respect to the assessment of ESV on a small scale, it is necessary to consider the determination of parameters and indicator values involved in each ESV assessment model. In this study, we used visits, actual measurements, etc., to obtain most of the indicator values, such as farmstay occupancy rates and prices; types, yields, and prices of agricultural and forestry products; soil bulk density; and nutrient element content. However, there are still some indicators that use empirical values from typical ecosystems because actual measurements are difficult to obtain, so the accuracy needs to be improved. Due to the spatial complexity of rural areas, there are many factors that affect the ESV, so ESV evaluation methods involving small-scale characteristics still need to be explored.

5. Conclusions

This study takes three villages, Zhenglong Village, Ziquejie Village, and Jizhai Village, which have different tourism models in the core area of Ziquejie Terraces, as examples. Based on the digital land use maps of remote sensing images of the three villages in 2006, 2014, and 2022, combined with the CICES classification standards, the land use changes and ESV changes in the three villages were measured. The impact of tourism models on the rural ESV was analyzed. The results showed that from 2006 to 2022, the built-up area in the three villages increased gradually and was mainly converted from farmland. In comparison, the dynamic degrees of built-up area and farmland in Zhenglong Village are the smallest, with the smallest degrees of change of −0.35% and 2.06%, respectively. The total ESV in Zhenglong Village increased by 0.35 times, the highest among the three villages. The ESV per unit area in Zhenglong Village increased the most, from 82,551 CNY in 2006 to 111,785 CNY in 2022. The increase in economic welfare per unit area and environmental welfare per unit area was also higher than in Ziquejie Village and Jizhai Village. This confirms that the cultural and tourism integration model can improve the utilization efficiency of rural ESV, affect the composition and intensity of land use, promote the conservation and improvement of ESV, and achieve the coordinated development of GIAHS site tourism and the ecological environment. In future development decisions, the impact of tourism models on land use and ESV should be fully considered to provide reliable support for tourism management decisions and ecosystem protection of GIAHS sites.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su16124945/s1, Table S1: Calculation formula of farmland ecosystem service value assessment; Table S2: Calculation formula of woodland ecosystem service value assessment; Table S3: Calculation formula of water ecosystem service value assessment; Table S4: Land use conversion matrix in Zhenglong, Ziquejie and Jizhai Villages, 2006–2022; Table S5: Land use conversion matrix in Zhenglong, Ziquejie and Jizhai Villages, 2006–2014; Table S6: Land use conversion matrix in Zhenglong, Ziquejie and Jizhai Villages, 2014–2022.

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