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Exploring the Economic Viability of Agro-Ecotourism as a Climate Change Adaptation Measure: A Travel Cost Approach

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Abstract: In this study, we employ the travel cost method to assess the viability of agro-ecotourism in Yuanshan Township, located within the fragile Lanyang River watershed. The local development of agro-ecotourism is the emerging measure that meets forest conservation and soil and water management in steep slopes and viable adaptation strategies in response to the urgent challenges posed by climate change. However, for long-term success, the self-sufficiency and livelihoods of local communities must be prioritized, especially since these communities heavily depend on local resources for their livelihoods. The study site demonstrates the economic success of agro-ecotourism, which allows visitors to utilize local resources and is crucial for boosting the local economy, by applying the travel cost method. This study evaluates the economic value of local natural resources, highlighting that visitor expenditure reflects both recreational resource use and local adaptation measures. The findings indicate significant estimated recreational resource values of TWD 15,748.03 by the negative binomial count data model (1 USD = 31.15 TWD). The results suggest that sustainable local agro-ecotourism measures, balancing conservation and to adapting climate changes, can enhance the economy while supporting residents' livelihoods in Yuanshan Township.

Keywords: climate adaptation; economic value; local industry; leisure; travel cost method

Academic Editor: Fabio Carlucci

Received: 22 February 2025
Revised: 13 April 2025
Accepted: 14 April 2025
Published: 15 April 2025

Citation: Chen, W.-J.; Jan, J.-F.; Chung, C.-H.; Liaw, S.-C. Exploring the Economic Viability of Agro-Ecotourism as a Climate Change Adaptation Measure: A Travel Cost Approach. *Sustainability* **2025**, *17*, 3564. https://doi.org/10.3390/su17083564

1. Introduction

Forest conservation is a critical and practical nature-based solution to climate change. Sustaining healthy ecosystems that can provide ecosystem services allows humankind to maintain tree-covered forests in climate-sensitive areas through the stewardship of forest ecosystem services [1,2]. The economic viability of nature-based solutions is essential for their success. This policy incorporates the question of who ecological resilience should benefit, raising the broader question: who should ecological resilience exist for? Tai [3] pointed out that relevant measures should coordinate the struggle of local residents to pursue social ecological resilience. The importance of local residents' livelihood and the critical role of economic viability in conservation for nature reserves were studied by Lu et al. [4]. It is possible that climate adaptation strategies based on forest conservation reduce impacts from natural disasters and mitigate climate shocks and simultaneously benefit the local economy. Community self-sufficiency in the vicinity of conserved areas can be enhanced by

developing recreational activities like ecotourism, which boosts economic vitality [4] and reduces economic pressure on land development in these regions [5]. The transformation of traditional local agriculture to leisure types would have the potential to mitigate climate shocks while benefiting local economies. Climate change has led to an increase in the frequency and intensity of extreme weathers, which may increase the risk of agricultural damage to local agricultural products that highly depend on weather conditions and affect residents' livelihoods. The climate adaptation measures of agricultural leisurization can be based on traditional agriculture by the introduction of accommodation, catering, and do-it-by-yourself processing. The transformation would create the opportunity to increase the stability of the local economy [5].

Yuanshan Township (YST) is located in a fragile and rugged mountainous area, most of which is forest land. It is nestled in the scenic landscapes of Yilan County, Taiwan, and boasts charming tourist attractions of traditional rural life and thriving leisure agriculture. With green mountains and meandering rivers, ecotourists are drawn to its natural landscapes and scenic delights. YST features magnificent natural scenery, including lush mountains, clear streams, and dense forests, attracting hikers, trekkers, and ecotourists.

The integration of leisure agriculture and ecotourism in YST represents not only an economic endeavor, but also a cultural and environmental pursuit. The synergy of agricultural innovation, environmental stewardship, and cultural preservation has made YST a travel destination to experience harmony between humans and nature, ensuring the continued prosperity and sustainability of rural communities [6–8]. This could improve resource efficiency, conserving biodiversity, and promoting rural heritage [5]. To counter the social, economic, and environmental challenges, the design of effective sustainable management measures is crucial to promote community engagement. The development of YST agro-leisure transformation is a down-to-top policy with intensive local participation.

Agrotourism in Taiwan is transforming from traditional tilling patterns by government initiatives to establish leisure agricultural zones [9]. YST features several recreational agricultural zones, each offering unique natural attractions: Zhentoushan Agricultural Leisure Area, Hengshantou Agricultural Leisure Area, and Dahudi Agricultural Leisure Area. These zones, alongside registered agrotourism farms, provide visitors with an immersive experience of rural life and recreational agriculture [6–8], allowing them to engage in hands-on farming activities, learn about traditional agricultural practices, and understand sustainable land management. This interaction not only enhances visitors' appreciation of rural culture, but also supports local farmers by generating additional income and promoting eco-friendly tourism.

Agriculture takes center stage in YST, where traditional farming practices yield various produce [6–8]. The transformation of leisure agriculture further promotes local prosperity and the vigorous development of the agricultural industry [10–12], and leisure agricultural zones have been created in Taiwan with government support [10]. YST's integration of leisure agriculture and ecotourism not only serves as an economic endeavor, but also reflects a cultural and environmental pursuit. This synergy promotes agricultural innovation, environmental stewardship, and cultural preservation, creating a harmonious relationship between humans and nature. Tourists, including those from the local community, nearby Taipei, and across Taiwan, visit YST to experience this unique blend of agriculture and ecotourism.

The local attractive destinations in YST include natural attractions and cultural attractions, such as the Fushan Botanical Garden, mountain trails, Shuang-lian-pi Wetland, Wang-long Pond, and Da-hu Park, and the King Car Group's Orchid Garden, etc. They also include tourist factories and farms, traditional temples, etc. These exciting destinations attract tourists from the local area, the adjacent metropolis of Taipei, and across Taiwan,

offering rejuvenation in the embrace of nature and cultural heritages. Tourists travel by private car, rental buses, vans, trains, or by renting local motorcycles and bicycles. According to government statistics, the number of tourists in Yilan County reached 6,701,360 in 2023; there are 176 agricultural leisure farms registered with YST, mainly located in three agricultural leisure areas. According to the official website of the YST Office, actively developing rural tourism remains a policy focus and efforts to promote it are still increasing [6–8]. According to Chen et al. [13], local transformation of agriculture to a leisure type presents a viable policy from a socio-economic perspective. This shift towards a hybrid leisure model has been recognized as a feasible long-term adaptation measure to mitigate climate change risks. Protecting the local forest ecosystem and its services is crucial, with forest conservation serving as a key eco-based adaptation strategy [14]. The investigation of local policy's economic viability can offer vital information to decision makers since the question of whether to conserve or reclaim/exploit scattered spots in local mountainous land is under debate, as addressed in the literature [5]. A study by Chen et al. [15] applied contingent valuation methods to assess the value of recreational resources in YST and proved the significant value generated by visitors. To ensure the development of reliable on-the-ground climate adaptation policies, economic viability should be thoroughly verified from multiple methodological perspectives.

Agro-ecotourism is a sustainable tourism model that integrates agricultural activities and ecotourism with potential ecological conservation practices, offering visitors experiences related to farming and environmental conservation and preservation [16]. The aforementioned YST's agro-ecotourism is a hybrid policy model and a natural-based solution to adapt to local climate change as it boosts social and natural resilience. The practices of YST's agro-ecotourism combines traditional agriculture with leisure activities and ecotourism. The present study investigates the economic value of YST's agro-ecotourism by using the travel cost method (TCM) to assess the value of recreational resources enjoyed by visitors. The income generation capability and economic viability of agro-ecotourism in YST can be empirically confirmed by adopting the travel market as a surrogate in the TCM model.

This hybrid policy approach not only enhances the economic viability of rural communities, but also promotes sustainable development, environmental conservation, and climate adaptation. The assessment in the present study serves to demonstrate the economic viability of ecotourism in entertaining visitors and potentially supporting the livelihood of the residents at the same time. The value assessment by TCM is based on the data collected through surveys conducted among tourists visiting YST. The survey gathered information on travel expenses, including transportation, accommodation, and other expenditures related to their visit. TCM utilizes these expenditures as a proxy to estimate the economic value of the recreational resources.

The primary objective of this study is to assess the economic value of recreational resources in YST using the TCM. It aims to examine how the integration of leisure agriculture and ecotourism contributes to the local economy while simultaneously supporting sustainable development and climate adaptation efforts.

2. Materials and Methods

2.1. Development and Significance of Agro-Ecotourism in Yuanshan Township

The study site in the present study is Yuanshan Township (YST) with 16 villages (Figure 1). The local residents are deeply land-reliant, traditionally involved in agriculture and currently involved in tilling and running the business of agro-ecotourism locally. These individuals are characterized by their dedication to working on the land. Their diligence

shines through in their tireless efforts, persistence, and wholehearted commitment to their work [6–8].

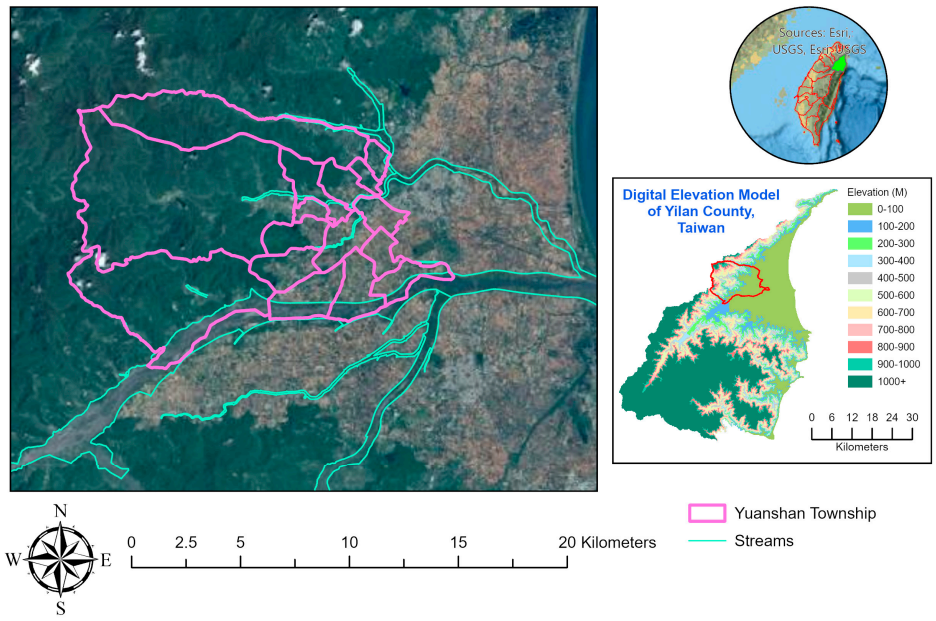

Figure 1. Location and digital elevation model of the study site of Yuanshan Township in Yilan County.

The vulnerability of YST illustrated the carrying capacity of the destinations. There are mainly three folds of local vulnerability that can be demonstrated by the digital elevation model in Figure 1.

1. The geographical vulnerability of YST: the pushing of the continental plate crust causes high height differences in a small area.
2. The climatic vulnerability of YST: the terrain of YST is directly on the windward side of the typhoon, facing increasingly strong winds and heavy rainfall due to climate change.
3. The economic vulnerability: agriculture has gradually declined in Taiwan, and calls for water, soil and environmental protection are growing. If the local mountain villages experience economic depression, it will cause livelihood difficulties for residents.

Based on the above information, the natural environment of YST inherently has a carrying capacity that is a crucial aspect for understanding the region's long-term sustainability. However, the development and prudent design of agro-ecotourism in YST have the potential to enhance carrying capacity by addressing and mitigating local vulnerabilities. Conserving forested land is a natural-based solution to climate change adaptation and represents a critical aspect of human–nature interactions. Government land use regulations based on scientific classifications are adopted to balance the conservation of marginal forest lands and tilling of traditional agriculture by the local community. By focusing on local resources and promoting eco-friendly tourism that supports both conservation and economic stability, agro-ecotourism can provide alternative livelihoods for residents, reduce economic depression in shallow mountain villages, and contribute to the long-term resilience of the area. Ultimately, with careful attention to these vulnerabilities, agro-ecotourism has the potential to not only protect the environment, but also boost the carrying capacity of YST, ensuring its sustainability in the future.

The township is a picturesque and beautiful place, surrounded by green mountains and rivers. Its stunning natural scenery, together with leisure agriculture activities, frequently attracts numerous visitors from the whole island of Taiwan. YST is regarded as the backyard of Taipei, situated just a mountain away from the city's dense urban areas.

It is known as one of the first destinations for those seeking a peaceful escape, offering tranquility to city dwellers. The distance is approximately 68.5 km, measured from Taipei City Hall to the Yuanshan Township Office.

Agricultural production and leisure agriculture is thriving in the villages of YST. The hilly terrain in YST has a climate conducive to the growth of various vegetables, fruits, and fruit trees such as tangerines, pineapples, bamboo shoots, ginger, starfruit, chives, guavas, wax apples, scallions, and Shanxi pears. During peak harvest seasons, the township offers agrotourism activities like fruit-picking, providing delightful experiences for family outings [6]. The township's rural scenery and diverse agricultural activities make it a prime location for agricultural leisure activities. Beyond its abundant natural resources, YST also boasts rich cultural resources. Agrotourism flourishes here, offering immersive experiences that connect visitors with the rural way of life. Government and community efforts converge to support small-scale farmers, foster innovation, and preserve natural beauty and cultural heritage [6].

The development of leisure agriculture in Taiwan was initiated in 2000. Taiwan's Agriculture Authority promotes agrotourism, highlighting its multifaceted benefits: economic, social, educational, environmental protection, recreational, medical, and cultural inheritance. The development of leisure agriculture is driven by changes in agricultural structure, urbanization, increased income, shifts in consumption patterns, more leisure time, and improved transportation infrastructure. As a result, traditional agriculture has transformed into leisure farms, integrating production, processing, sales, and tourism to enhance local community income and meet recreational demands [4,12]. Furthermore, local institutional development and organizational establishment has been made for advancing urban agriculture tourism. The establishment of leisure agriculture zones in Taiwan, promoted by the Council of Agriculture, aims to combat the declining role of traditional agriculture, meet the increasing demand for recreation, and strengthen local community income. Within these zones, the government establishes and maintains public infrastructure. Community-based governance ensures that leisure agricultural activities are planned and managed in a format of income creation to meet local feasibility, leading to a comprehensive strategy for agricultural product planning, marketing, and promotion [10]. Taiwan's leisure agriculture has been developing for decades, with significant progress up until the execution of this study's survey in 2023. Through the promotion of Leisure Agriculture zones in local areas, the development of leisure agriculture in Taiwan has proven successful, particularly in agricultural counties such as Yilan County [6–8].

In 2023, YST hosts three main recreational agricultural zones: Zhentoushan Agricultural Leisure Area, Hengshantou Agricultural Leisure Area, and Dahudi Agricultural Leisure Area. These zones feature flocks of agrotourism farms and provide a blend of recreational agriculture and forest ecotourism in the nearby forests. The main attraction of leisure agriculture in YST lies in utilizing the rich rural produces, natural landscape, rural culture, and local characteristics. This combination with ecological tourism develops high-quality tourism that offers entertainment, recreation, education, economic benefits, environmental protection, and health benefits [6].

The hilly terrain serves as an ecotourism destination, with forest protection as a nature-based climate adaptation strategy. YST and the Lanyang River watershed are geologically and climatically fragile areas where forests play a crucial conservation role. Taiwan's community forestry program empowers local residents in forest management, addressing long-standing issues of land reclamation and illegal logging through co-management [17,18]. Integrating forestry ecotourism with leisure agriculture has become a policy solution to farmers' livelihood challenges, offering climate adaptation opportunities [13]. This approach improves environmental quality, balances ecosystem and land use, aids soil and

water conservation, and preserves landscapes and cultural assets. It provides recreation for visitors from Taipei and Yilan County, delivering benefits such as stress relief, rural cultural connections, and improved quality of life [10].

2.2. Travel Cost Method

In the context of nature-based solutions to the increasingly severe environmental and climate challenges, assessing the value of natural resources and ecosystem services is crucial for developing strategies that promote ecological protection and facilitate the rational use of land. The travel cost method (TCM) is a widely used non-market valuation technique to estimate economic values associated with ecosystems or recreational sites. It is based on the premise that the travel cost incurred by visitors can be used to derive a demand curve for a recreational site. This method is mainly applied to regions rich in natural and cultural tourism resources, using the tourism market as a surrogate market for the value of ecosystem services to estimate their worth. The theoretical and empirical development of TCM has been significantly advanced by key works, notably those of Clawson and Knetsch [19] and Parsons [20]. Furthermore, Freeman [21] and Freeman et al. [22] provided a comprehensive guide to measuring environmental and resource values, including the calculation of consumer surplus using TCM. Haab and McConnell [23] discussed various econometric approaches to non-market valuation, including detailed explanations of consumer surplus calculations by TCM. Parsons [20] offers a primer on non-market valuation techniques, with practical examples of consumer surplus calculations in TCM.

Recreational activities have gained more attention in recent years, and there has been a surge in the literature estimating the services value of ecosystems using the TCM. Sinclair et al. [24] estimated the economic value of natural ecological recreational resources using the TCM, providing strong evidence for the need to protect environmental ecosystems and promoting the rational use of land. Swinton et al. [25] analyzed the relationship between ecosystem services and leisure agriculture using the TCM, evaluating the value of leisure agriculture tourism supported by a healthy agricultural ecosystem. Ezebilo [26] assessed the non-market value of ecosystem services through the economic evaluation of natural recreation in Sweden. Wilson and Carpenter [27] analyzed the economic value of ecosystem services in U.S. freshwater bodies, and Nandagiri [28] evaluated the economic value of lake ecosystems.

When modeling the number of visits to a recreational site, count data models are often used due to the discrete nature of the dependent variable (i.e., the number of visits). Studies involving the application of count data models for TCM include Haab and McConnell [23] and Cameron and Trivedi [29]. The count data model should be used, including Poisson count regression and negative binomial count regression. Both methods were applied in the assessment for recreation value. The Poisson model assumes that the mean and variance of the count variable are equal (equi-dispersion). The negative binomial model relaxes the equi-dispersion assumption of the Poisson model by allowing the variance to exceed the mean. For a count data model, the maximum likelihood estimation (MLE) technique is applied to estimate parameters. However, if the survey is conducted at an entertainment venue, the on-site survey will only include actual visitors and truncate potential visitors who do not come to the survey site. Shaw [30] addressed these on-site truncation problems in his paper and applied on-site Poisson regression to model the demand for recreation in Montana, considering factors such as travel cost, time, and socio-economic characteristics. Englin and Shonkwiler [31] utilized the Poisson model to analyze the demand for recreational fishing in the United States, focusing on travel cost and site quality. Furthermore, Creel and Loomis [32] employed the negative binomial model to

study the demand for deer hunting in California, accounting for overdispersion in the number of hunting trips. Hellerstein and Mendelsohn [33] used the negative binomial model to estimate the demand for outdoor recreation in the Adirondacks, incorporating variables such as travel cost and site characteristics.

Moreover, an array of studies has applied these two methods. Grogger and Carson [34] applied and compared the Poisson and negative binomial models in recreational demand, highlighting the importance of addressing overdispersion to improve model accuracy. Martinez-Espineira and Amoako-Tuffour [35] conducted a comparative analysis of Poisson and negative binomial models for the valuation of national parks in Ghana, demonstrating the superiority of the negative binomial model in handling over-dispersed data. Although the TCM has been utilized for a long time, in recent years, there have been new applications in assessing the value for recreation, including Mohamed et al. [36], Chettri and Kundu [37], Aksoy et al. [38], Verde [39], and Chapagain, Poudyal, and Watkins [40].

The aforementioned literature demonstrates that numerous studies have developed and used the TCM to estimate non-market values of ecosystem services, confirming that it is a relevant tool for this task. Therefore, this study considers agro-ecotourism in Yilan's shallow mountain area as a local surrogate market to assess the value of ecosystem services from local natural resources. This estimated value will serve as an important foundation and driving force for balancing local natural ecosystems, climate change, human development policies, and strategic planning in the shallow mountain leisure agriculture areas. The results could be applied to affirm that the local agro-ecotourism can enhance local community income and meet recreational demands, as proposed by Liu et al. [41] under a well-designed forest conservation policy.

The steps of the TCM are as follows: visitor survey, demand curve estimation, and consumer surplus calculation.

Step 1: A visitor survey was conducted to collect data on visitors' travel costs, the number of trips made, socio-economic characteristics, and time spent at the site. Travel costs generally include direct costs actually expended in the trip, such as transportation and accommodation costs, and the indirect costs, such as the opportunity cost of time. Since the survey was carried out during a holiday period, the opportunity cost of time was not included in the present study. In the present study, six topics of questions were included in the survey questionnaires: (1) visiting information of respondent visitors, (2) departure places and transportation of visitors, (3) most valuable recreation resources to be protected as perceived by the respondents, (4) revisit Intention, (5) feasible institution to protect local natural recreation resources, and (6) demographic characteristics of the respondents.

Step 2: The relationship between visiting frequency and travel costs was used to estimate the demand curve. Typically, a negative relationship is expected. A demand function can be expressed as follows:

$$Q = f(TC, X) \tag{1}$$

This demand function relates the number of visits, Q, to travel cost, TC, and a vector of other variables, X.

For a count data model, the demand function can be expressed as follows:

$$\mathrm{E}(Q_i \mid X_i) = \exp\left(\beta_0 + \beta_1 TC_i + \sum_{j=2}^{k} \beta_j X_{ij}\right). \tag{2}$$

where β_0 is the intercept, β_1 is the coefficient for travel cost TC, and β_j are the coefficients for other explanatory variables X_j, the subscript j is the j-th independent variables and subscript i is the i-th respondent, and k is the sample size.

Step 3: Consumer surplus calculation is based on the area under the demand curve representing the consumer surplus, which is a measure of economic value. The consumer surplus of the demand curve in the TCM represents the difference between what visitors are willing to pay for access to a recreational site and what they actually pay. It is often calculated using the estimated demand function derived from the TCM model. In the aforementioned literature, Freeman [21] and Freeman, Herriges, and Kling [22] provide comprehensive methods for measuring environmental and resource values and discuss the theoretical foundations of consumer surplus calculations. The book by Haab and McConnell [23] covers econometric techniques for non-market valuation, including detailed procedures for calculating consumer surplus using TCM models. Based on the formula in the literature (P279, Freeman, Herriges, and Kling [22]; P167, Haab and McConnell [23]), the economic value represented by consumer surplus for an average visitor is given by the following:

$$CS = -\frac{1}{\beta_1}. \quad (3)$$

where β_1 is the coefficient of variable of travel cost, *TC*, in Equation (2).

2.3. Survey Data Descriptive Statistics

To collect information on the visitors' travel expenditure to represent the value of the local recreational resources, an on-site questionnaire survey was carried out during peak travel season in January and February in 2023, which is around the Chinese Lunar New Year. The survey was prepared from in-person interviews in YST recreational resorts. A total of 500 residents were randomly selected by the convenient sampling method, and the number of incomplete questionnaires reached 100 samples. A total of 400 respondents completed the questionnaire.

The data descriptive statistics of six parts of questions in the survey questionnaires are presented in Tables 1–6, corresponding to the six parts of questions in the survey questionnaire. The tables contain data from the survey, offering insights into various aspects of the respondents' visiting habits, preferences, and demographics.

Table 1. Visiting information of respondent visitors.

Visiting Information	Mean	S.D.
Visit number to Yuanshan Township in the past year (time)	2.78	4.06
Travel distance (km)	109.55	112.53
Travel time (single trip, h)	2.54	3.11
Stay time (h)	10.84	17.57
Number of people traveling together (headcount)	5.83	3.71
Travel expenses (TWD per person)	5616.74	5345.32
Ratio of single destination (Yuanshan Township only)	0.71	0.38

Note: Travel expenses include expenditures on food, accommodation, and transportation in the visit in TWD per person. Ratio of single destination is the ratio calculated by setting single destination (Yuanshan Township only) = 1, and multiple destination = 0.

In Table 1, it is shown that respondents visited YST an average of 2.78 times in the past year, traveling an average distance of 109.55 km with a single trip taking approximately 2.54 h. They stayed in the township for an average of 10.84 h, traveling with an average group size of 5.83 people, and spending an average of TWD 5616.74 per person (1 USD = 31.15 TWD). Notably, 71% of the trips were solely to YST, indicating a high ratio of single-destination visits.

Table 2 highlights the distribution of departure places and transportation modes used by the visitors. A significant majority, 55%, departed from the northern region, while 17% were from within Yilan County. Smaller percentages came from the eastern,

middle, and southern regions, with only 1% from other places. In terms of transportation, 74% of respondents traveled by car, with fewer choosing bicycles (1%), locomotives (12%), passenger transport (3%), and buses (10%).

Table 2. Distribution of departure places and transportation of visitors.

	Number of Respondents	(%)
Place of departure		
Within Yilan County	68	17%
Eastern region	23	6%
Northern region	220	55%
Middle region	42	11%
Southern region	42	11%
Other places	5	1%
Transportation (multiple choices)		
Car	303	74%
Bicycle	5	1%
Locomotive	49	12%
Passenger transport	14	3%
Bus	41	10%

Table 3 explores the recreational resources that respondents consider most valuable to protect. Natural resources, including landscapes, flora, and fauna, were highly valued by 70% of respondents. Human resources, such as agricultural culture and local drama, were important to 19%, while recreational facilities were valued by 10%. A small percentage, 1%, had other preferences.

Table 3. Most valuable recreation resources to protect, as perceived by the respondents.

Uniqueness of Local Recreational Resources (Multiple Choices)	Number of Respondents	(%)
Natural resources (landscape, flora and fauna, ecology)	376	70%
Human resources (agricultural culture, local drama)	101	19%
Recreational facilities	54	10%
Others	7	1%
Total (%)	538	100%

Table 4 examines the revisit intention of respondents using a five-point Likert scale. The data show a general interest to revisit, with most respondents agreeing with the statements about revisiting in the near future (mode = 4), recommending YST to friends and relatives (mode = 4) and prioritizing it for their next travel (mode = 4).

Table 4. Revisit intention.

Revisit Intention	5	4	3	2	1	Mode
Revisit Intention 1. I will revisit YST in the near future	201	225	25	1	0	4
Revisit Intention 2. I will recommend my relatives and friends to visit YST	192	223	35	2	0	4
Revisit Intention 3. YST is the first priority for my next travel.	137	184	121	7	3	4

Note: The agreement of the statements of the revisit intention is reported by applying Likert five-scale measures. It is measured by a 5-point Likert-type scale, with strongly agree, agree, neutral, disagree, and strongly disagree for the scores of 5, 4, 3, 2, and 1, respectively. The number of respondents and mode of each statement are reported.

Table 5 identifies the institutions that respondents believe would be most effective in protecting local natural recreational resources. The Yilan County Government was the most preferred, with 38% support, followed by the Office of Recreational Agricultural

Zone at 30%, and the Yuanshan Township Office at 15%. Other institutions, such as the Committee Office of Community Management (11%), a private foundation (4%), and others (2%), received less support.

Table 5. Feasible institution to protect local natural recreation resources.

Institution	Number of Respondents	(%)
Office of recreational agricultural zone	119	30%
Committee Office of Community Management	45	11%
Yuanshan Township Office	60	15%
Yilan County Government	152	38%
Impartial and detached private foundation	16	4%
Other	8	2%
Total	400	100%

Finally, Table 6 provides demographic information about the respondents. The gender distribution was fairly balanced, with 52% male and 48% female. The majority of respondents were aged 21–29 years (37%), with lower representation from those under 20 years and over 60 years. In terms of education, most respondents had completed senior high school (68%). The occupational distribution showed that 42% were in industrial, commercial, and service sectors, while 20% were students. Monthly income varied, with the largest group (23%) earning less than TWD 20,000.

Table 6. Distribution of demographic characteristics of the respondents.

	Number of Respondents	(%)
Gender		
Male	234	52%
Female	220	48%
Age (years old)		
<20	1	0%
21–29	166	37%
30–39	115	25%
40–49	80	18%
50–59	79	17%
60	13	3%
Education		
Elementary	8	2%
Junior high school	83	18%
Senior high school	307	68%
University	52	12%
Graduate school	1	0%
Occupations		
Agriculture	5	1%
Industrial, commercial, and service sectors	190	42%
Military, public, and educational sectors	35	8%
Freelancer	44	10%
Students	92	20%
Housewife	23	5%
Others	65	14%

Table 6. *Cont.*

Personal monthly income (TWD)		
<20,000	92	23%
20,001–25,000	23	6%
25,001–30,000	28	7%
30,001–40,000	55	14%
40,001–50,000	52	13%
50,001–60,000	46	12%
60,001–70,000	22	6%
70,001–80,000	29	7%
80,001–90,000	16	4%
>90,001	36	9%

Note: The mean value of personal monthly income is 45,354.24 and standard deviation is 23,368.58 TWD. The average year of schooling is 15.31, with standard deviation 2.13.

2.4. Model Specification, Variable Definitions, and Descriptive Statistics

The final model specification for the travel demand model is given by Equation (4).

Based on the count data model in Equation (2), the specifications selected for this study are presented in Equation (4). The independent variables in Equation (4) include either statistically significant determinants identified through the interpolative and extrapolative mechanisms or key variables that are statistically insignificant but relevant for policy implementation in decision-making. All of the variables in Equation (4) are measured on a per-person basis.

The variable Q represents the visit time in the past year. X represents the vector of independent variables, and E(Q | X) denotes the conditional expectation of Q given X. The variable *Cost* represents the price of the visit. The price is measured by travel expenditure per trip per person. It is the cost of the traveler's single visit. The DF_I variable is a dummy variable representing departure from Yilan, where local visitors are coded as 1, and all others as 0. Since the survey was conducted around the Lunar New Year in 2023, the respondents' leisure time and the opportunity cost of foregone wages were negligible, so time value represented by wages was not considered in the travel cost model (TCM) model specification. However, the variables for travel time and stay duration were still included in the model to demonstrate if they are significant. The variables of $TRAVEL$ and $STAY$ are the travel time and duration of stay, measured in hours. DEST is the destination dummy, where a value of 1 indicates a single stop to Yuanshan Township and 0 otherwise. The variable AGE represents the visitor's age, measured in years. Since we assume the variable of AGE is likely non-linearly related to the dependent variable, Q, the specification of our final choice are quadratic function of variable AGE. $INCOME$ is the variable representing the total monthly income, which includes both the fixed salary and additional sources of income such as rental income, investments, and freelance work.

The corresponding variable definitions are defined, and descriptive statistics are calculated, please refer to the definitions and corresponding statistics in Table 7. The results of the statistical tests are reported in Table 8 and the interpretation of regression results are illustrated in the next section.

$$E(Q \mid X) = exp\left(COST_{PER_{PERSON}}, DF_I, TRAVEL_{T_{HR}}, STAY_{T_{HR}}, DEST_{YST_{ONLY}}, AGE, AGE \times AGE, INCOME\right). \quad (4)$$

The descriptive statistics of variables in Table 7 provide a comprehensive snapshot of the variables included in the regression analysis. The data highlight key aspects such as the average number of visits to YST in the past year, which stands at 2.78 times with a relatively high standard deviation of 4.06, indicating high variability among visitors in their

visit frequency. The high disparity of the visiting frequency indicates the appropriateness of adopting the negative binomial count data model.

Table 7. Variable definitions and data statistics.

Variable	Definitions	Mean	S.D.	Min	Max
Q	Visit number to Yuanshan Township in the past year (times)	2.78	4.06	1	20
$COST_{PER_{PERSON}}$	Travel expenses (TWD per person)	5616.74	5345.32	1000	25,000
DF_I	Departure dummy, departure from Yilan (local visitors) = 1, otherwise = 0.	0.17	0.14	0	1
$TRAVEL_{T_{HR}}$	Travel time (single trip, h)	2.54	3.11	0.5	6.5
$STAY_{T_{HR}}$	Stay time (h)	10.84	17.57	1	72
$DEST_{YST_{ONLY}}$	Destination dummy, single stop to Yuanshan Township only = 1, otherwise = 0.	0.71	0.38	0	1
AGE	Age (years old)	36.77	12.33	20	60
AGE × AGE	Age squared.	-	-	-	-
INCOME	Personal monthly income in TWD.	45,354.24	23,368.58	20,000	90,000

Table 8. Estimated regression results of the travel cost model.

Variable	On-Site Negative Binomial Count			On-Site Poisson Count		
	Coefficient	Prob.		Coefficient	Prob.	
C	0.070141	0.9386		0.073407	0.8707	
$COST_{PER_{PERSON}}$	−0.000064	0.0026	**	−0.000075	<0.0001	***
DF_I	0.755720	<0.0001	***	0.760287	<0.0001	***
$TRAVEL_{T_{HR}}$	−0.030628	0.4124		−0.041520	0.1359	
$STAY_{T_{HR}}$	0.006682	0.0802		0.008906	<0.0001	***
$DEST_{YST_{ONLY}}$	−0.013556	0.9312		−0.053335	0.5228	
AGE	0.059245	0.2493		0.059903	0.0179	*
AGE × AGE	−0.000669	0.2845		−0.000763	0.0140	*
INCOME	0.000001	0.7891		0.000005	0.0139	*
S.E. of regression	4.6244			4.5374		
Sum squared resid	3827.9090			3685.3020		
Log likelihood	−436.7113			−569.5550		
Restr. log likelihood	−694.0283			−694.0283		
Avg. log likelihood	−2.3229			−3.0295		
E(WTP)	15,748.0315			13,351.1349		

* indicates $p < 0.05$, ** indicates $p < 0.01$, *** indicates $p < 0.001$.

Travel expenses per person are on average TWD 5616.74, showing considerable variability with a standard deviation of TWD 5345.32, suggesting diverse spending patterns among visitors. Additionally, the departure dummy variable (DF_I) indicates that 17% of visitors depart from local Yilan county, distinguishing local visitors from others. The mean travel time per single trip ($TRAVEL_{T_{HR}}$) is 2.54 h, with a standard deviation of 3.11 h, reflecting variability in travel distances or modes among visitors. Stay time in YST ($STAY_{T_{HR}}$) averages at 10.84 h, though with a larger standard deviation of 17.57 h, suggesting varying durations of visitor stays.

The destination dummy variable ($DEST_{YST_{ONLY}}$) indicates that 71% of visits involve YST as the sole destination, illustrating its appeal as a primary destination for many visitors. Demographically, visitors have an average age of 36.77 years, with a standard deviation

of 12.33 years, indicating a diverse age range among tourists. Personal monthly income (INCOME) among visitors averages 45,354.24, with a standard deviation of TWD 23,368.58, highlighting varying economic backgrounds among travelers.

3. Results

Since the yearly visit time is a non-negative integer and the survey was conducted on-site, the negative binomial count and the Poisson count regression techniques were applied for this estimation. The Poisson count regression assumes equal mean and variance, while the negative binomial count regression is suitable for data with higher dispersion. Table 8 presents the estimated results of the demand regression specifications of the travel cost method (TCM) using data collected from the survey.

Based on the dispersion of the dependent variable Q shown in Table 7, with a mean of 2.78 and a standard deviation of 4.06, the negative binomial model is appropriate for fitting the collected data. Therefore, the estimated values based on the negative binomial model are used to present the analysis results.

Based upon the significance of the regression estimation results by negative binomial model, the visiting frequency of tourists is negatively related to the travel cost and positively related to dummy variable of Yilan local visitors and stay hours. The visiting frequency is not significantly correlated with travel time, the destination dummy variable for a single stop to Yuanshan Township (YST), age, and monthly income of the visitors.

Furthermore, based on Equation (3), the consumer surplus values representing the economic value of an average visitor to approximate the recreation resource value (E(WTP)) are 15,748.03 and 13,351.13 TWD based on the two models adopted, respectively. The value estimated by the negative binomial count data model is more reasonable than that estimated by Poisson regressions, since the data of the variables demonstrated a high disparity with a high standard deviation (Table 7). The high value generated from the TCM may imply that local sustainable measures can enhance the economy by utilizing recreational resources in YST.

4. Discussions

4.1. Local Policy Implementation for Agro-Ecotourism Promotions

The regression estimation results of the present study by the travel cost method (TCM) indicate several key factors influencing the visiting frequency of tourists, which has implications for YST policies. Local agro-ecotourism could be further developed based on the estimated results of the regressions.

(1) Promotions targeted to local visitors: since visiting frequency is positively related to being a local visitor from Yilan, the marketing and promotional campaigns should target local populations more aggressively. Local tourism boards can collaborate with local businesses to create special offers for residents, thus boosting local tourism.
(2) Enhanced visitor experience: since visiting frequency is positively related to the duration of stay, policies to enhance the visitor experience by developing amenities and activities that encourage longer stays can increase visit frequency. Investment in high-quality facilities, guided tours, and diverse recreational activities would attract visitors who are likely to stay longer and visit more frequently.
(3) Minor strategies of age-based segmentation strategies: some ago-farm promotion activity is age-specific, this investigation evidenced that these promotion strategies for YST visitors are minor in local operation practices of agro-ecotourism, as indicated by the insignificant relationship between visiting frequency and the age of visitors.
(4) Developing multi-stop tourist packages: policy changes should be made based on the finding that visiting frequency is not significantly related to travel time or the

destination being a single stop. As indicated by the evidences that the travel time and single-stop destinations are not significant factors, developing multi-stop tourist packages that include YST can further promote tourism.

By addressing these factors through targeted policies, local authorities can boost tourism in YST, simultaneously fostering economic growth.

4.2. Theoretical Foundation of Travel Cost Method Applied

While the TCM is a valuable tool for estimating the value of recreational sites, its theoretical foundations require careful consideration, particularly when generalizing its results or applying it to complex, multifaceted environmental resources. The theoretical implications of the TCM reveal several challenges inherent in the approaches of the TCM, such as the assumption of rational behavior, difficulties in measuring time and opportunity costs, and the challenge of accounting for heterogeneous preferences. However, in this investigation, the visitors are assumed behave in rational behavior. The survey was conducted during holidays; hence, the bygone salary, often used as value proxy of the travel opportunity cost and the time spent in travel, can be omitted in this research. The studied travel destinations in YST are common of rural and ecological attributes, and hence the travelers are assumed of homogeneous travel utility.

Notably, high proportion of the trips were solely to YST. In fact, the single-destination visits are made possible by the freeway across the Lan-yang River watershed, allowing the passengers to travel to other destinations. Hence, the estimated travel value in this investigation can be a precise measurement without complicated problems associated with multi-destinations.

4.3. Valuation Comparison

Both the TCM and contingent valuation method are widely used to assess the economic value of non-market recreational resources. The TCM relies on a surrogate market based on resources used for recreation. A surrogate market refers to a substitute or indirect market used to estimate the value of a good or service that does not have a direct market price. The visitor does not pay to visit the agro-ecotourism in YST. Since there is no direct price for the enjoyment of the site itself, the surrogate market is the money spent on related activities. This helps estimate the economic value of the site by associating it with the costs incurred in reaching or using it.

The contingent valuation method is based on a hypothetic market and a stated value of the respondent in survey. The contingent valuation method remains one of the most widely used methods for valuing non-market goods, especially in policy-making and environmental economics.

In the present study, a reasonable estimate for the value of recreational resources in YST is reported as TWD 15,748.03 from the negative binomial count data model by the TCM, given the high disparity in the data (Table 7). The high value from the TCM suggests that local sustainable measures could boost the economy by utilizing YST's recreational resources. The same research group previously assessed the economic value of YST agro-ecotourism using the contingent valuation method [16], reporting a value of TWD 1002.00. The differences in the estimated economic value of local agro-ecotourism resources stem from the methodologies used.

4.4. Agro-Ecotourism and the YST's Adaptation to Climate Change

Agro-ecotourism in YST is a sustainable tourism model that integrates transformation of traditional agriculture to leisure-type, set against the backdrop of beautiful natural landscapes. This form of tourism is the hybrid of agritourism and ecotourism. It not

only provides an opportunity for farm diversifications and income generations, but also contributes to environmental conservation and supports local climate adaptations. Under urgent climate change, the climate change is happening rapidly and requires immediate attentions or actions to constructing the resilient system of the society and the natural environment. Local farm practices for agro-ecotourism harmonize with climate adaptation measures of forest conservation, soil and water conservations, land use planning, in the vulnerable steep terrain.

Being a surrogate, the travel market under the investigation of the TCM is an authentic existing exchange market system. The estimated high value of YST recreation and so as to the local resources, the practices of agro-ecotourism in YST are high value-added economic activities, accurately conforming to the reality or facts. The local agro-ecotourism components on the farm side provide the visitors with farm experiences.

It is worth noting that the adoption of agro-ecotourism and corresponding practices is highly regionally differentiated, and the role of income generation remains consistent across different cases. A conceptual framework for agro-ecotourism was developed based on the local attributes of coastal regions in India, engaging tourists through activities such as the sale of farm products, educational experiences, hospitality services, outdoor recreation, and entertainment [16]. In the case studied by Kumar et al. [16], a key aspect of policy compliance and feasibility is making policy practices more accessible to visitors while ensuring they are beneficial to farmers.

Moreover, agro-ecotourism can be a measure of natural-based solutions by supporting the offering of ecosystem services that contribute to environmental and economic sustainability. Importantly, active participation from local communities has fostered YST's agro-ecotourism and helps stimulate the local economy. It creates opportunities for developing a diverse and inclusive economic model, contributing to income generation. Moreover, it not only minimizes environmental harm, but also leverages natural amenities to enhance the quality of local tourism. Through the promotion of sustainable agricultural practices and active community involvement, agro-ecotourism provides a pathway to enhance both tourism and agriculture in a balanced, environmentally friendly way. Moreover, it supports local climate change adaptations as the government had regulated the use of land in the local fragmented and steep terrain in the manner of forest conservations [5].

5. Conclusions

Forest, soil, and water conservation in steep slope areas has emerged as a viable adaptation measure in the face of the current climate change emergency. Conserving land for forests is a nature-based adaptation strategy that sits at the forefront of human–nature interactions. For these adaptation measures to be successful in the long term, it is crucial to ensure the self-sufficiency and livelihoods of local communities, particularly those that are heavily reliant on local resources for their sustenance. Although government regulations based on scientific land classifications govern land use, marginal forest lands traditionally used for agriculture by local communities remain vital to their livelihoods.

The present study applies the travel cost method (TCM), adopting the travel market as a surrogate market to assess the economic value of local natural resources. The travel expenditure of visitors serves as a proxy in assessing the value of the visitors for the utilization of these resources for recreation purposes. This study specifically examines Yuanshan Township, a region that is climatically, geographically, and socially fragile.

Using data collected from on-site surveys, this study employs negative binomial count regression techniques to estimate the economic value of recreation resources in Yuanshan Township. The findings, presented in Table 7, show that the point estimate of the recreation resource value (E(WTP)) is TWD 15,748.03. The results indicate that agro-

ecotourism, through government regulations aimed at alleviating and adapting to climate change, can simultaneously secure residents' livelihoods by leveraging the economic value generated from visitor spending. There are some limitations and future research directions for this study. Despite the valuable insights provided by this study, several limitations should be acknowledged. First, the study relies on travel cost data as a proxy for the economic value of natural resources, which may not fully capture non-market values such as cultural significance and ecosystem services. The present study could be a conservative estimate, and offers an estimate that is deliberately kept on the lower or more cautious side to avoid overestimation. Future research could integrate additional valuation methods, such as contingent valuation or choice experiments, to provide a more comprehensive assessment. Second, the study is geographically limited to Yuanshan Township, which, while representative of certain rural and mountainous communities, may not be generalizable to other regions with different socioeconomic and environmental conditions. Expanding the research to other locations with similar ecological and social contexts would enhance the applicability of the findings. Third, visitor preferences and travel behavior may change over time due to factors such as policy shifts, climate variations, or economic fluctuations. The seasonality patterns of the local agro-ecotourism could be an important issue to be addressed in the future study. Longitudinal studies that track changes in visitor demand and spending patterns could provide deeper insights into the sustainability of nature-based adaptation strategies. Finally, while this study highlights the economic value of natural resources through tourism, future research should explore additional livelihood diversification strategies that balance conservation efforts with community development. Investigating the integration of agroforestry, ecotourism, and sustainable agriculture into local adaptation strategies could offer a more holistic approach to rural resilience.

By addressing these limitations and expanding the scope of analysis, future research can further contribute to the development of sustainable and inclusive adaptation strategies that support both environmental conservation and local livelihoods.

Author Contributions: Conceptualization, methodology, investigation, software, validation, formal analysis, writing, and editing: W.-J.C.; organization of the research project, survey design, paper review, and paper submission: S.-C.L.; research project administration, W.-J.C., J.-F.J., C.-H.C. and S.-C.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Science and Technological Council, Taiwan (grant number: NSTC 113-2321-B-004-001).

Institutional Review Board Statement: Ethical review and approval were waived for this study due to the Human Subjects Research Act in Taiwan: "Scope of Human Research Cases Exempt from Ethics Review Committee Evaluation".

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available from the corresponding author upon request.

Acknowledgments: We gratefully acknowledge the five reviewers for their helpful comments and suggestions. We acknowledge the following interviewers for the in-person survey: W.J. Chen, S.Y. Kuan, J.H. Fan, T.T. Hsieh, and W.M. Hsieh.

Conflicts of Interest: The authors declare no conflicts of interest.

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