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Research on Environmental Protection of Rural Ecotourism Based on PSR Model

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ABSTRACT

This paper examines the relationship between rural ecotourism development and environmental protection in Province A, utilizing the PSR model and GAs. It employs a detailed evaluation of indicators in the tourism economy and ecological environment modules, using mathematical modeling and weight coefficient calculations to assess the impact of tourism activities. GAs are used to navigate the complex problem space inherent in balancing economic development with ecological sustainability. By analyzing data from 2005 to 2018, the coupling degree between tourism economy and ecological environment gradually increased from 0.1 to 0.6398. The results indicate a strengthening relationship between tourism economy and ecological environment, moving towards good or high-quality coordination. The degree of coupling, as measured by the PSR model, reflects the evolving interaction between rural tourism development and environmental protection. The findings provide valuable insights for policymakers and stakeholders in balancing economic growth with environmental sustainability in rural areas.

KEYWORDS

Environmental Protection, PSR Model, Rural Ecology, Rural Ecotourism

China has never overlooked the development of rural areas, and the 19th National Congress introduced the fundamental principles of rural civilization, thriving industry, prosperous life, ecological livability, and effective governance for rural revitalization (Li et al., 2023a). The continuous advancement of rural areas, along with the transformation and upgrade of the agricultural sector, has correspondingly propelled rural tourism (Ji & Chen, 2022). Rural tourism encompasses new forms of tourism such as rural health preservation, sightseeing, and agricultural science promotion and experience (Jiang et al., 2022). In this context, China strongly advocates and supports the development of rural tourism, which has led to a gradual increase in the number of people engaging in rural tourism and rapid growth of the rural tourism industry, generating positive economic benefits for the countryside (Yao & Liu, 2020). In 2019, the number of rural tourists even reached 3.2 billion, with an operating income of 850 billion yuan. However, from January to August 2020, the number of rural tourists decreased by 60.9% compared to the previous period, totaling 1.207 billion. Following the COVID-19 pandemic, with the gradual resumption of production and daily life, urban and rural residents continue to fulfill

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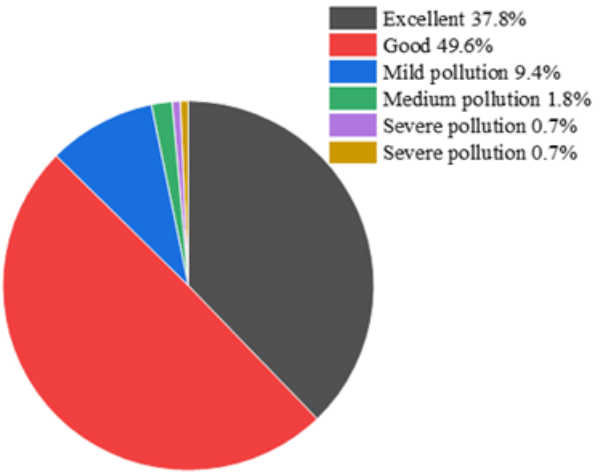
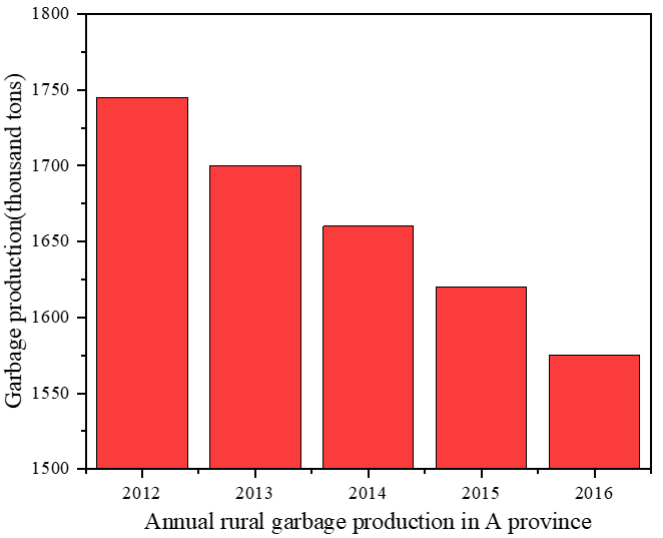
Figure 1. Rural Air Quality in Province A



previously suppressed demands (Wu et al., 2024). The environment has become clearer, and the charm of the countryside now holds greater appeal to people, resulting in an increase in environmental pollution. As depicted in Figure 1, the air quality optimization rate is only slightly above 30%, less than half of its pre-pandemic levels.

In the current situation, rural tourism development is thriving. China's rural tourism economy has entered a stage of steady progress (Tian et al., 2022). However, the ecological environment has suffered some damage. While people's awareness of ecological environmental protection has improved to some extent, various factors continue to cause pollution to the environment (Zhou & Sun, 2022). These include shallow environmental protection awareness, decreased arable land and agricultural resources, intensified rural environmental damage and pollution, and fast-paced yet environmentally unfriendly economic development (Xiang & Yin, 2020). Since the ecological environment forms the basis for promoting rural tourism development, it is imperative to prioritize ecological environmental protection in tandem with the development of rural tourism (Megawati et al., 2022). Additionally, if rural tourism development exceeds its capacity, it will inevitably face resistance from the ecological environment, leading to increased constraints. The imbalance between rural tourism development and environmental protection often results in environmental pollution, excessive development and utilization of regional resources, and disruption of regional biological chains (Tong et al., 2024). Province A is renowned for its diverse national culture, unique customs, and rich morphological and geomorphological conditions, making it a prominent tourism province in China and providing a solid foundation for the development of rural tourism (Cheng et al., 2023). Nevertheless, it grapples with ecological and environmental challenges such as water pollution, ecological damage, soil erosion, biodiversity loss, and reduction in forest area. The interplay between tourism development and the ecological environment is complex in this province (Gu et al., 2022). While academic research delves into the coupling and coordination between the tourism industry and the ecological environment, there is a scarcity of literature about Province A. This paper establishes the Pressure-State-Response (PSR) framework for the coupling mechanism of rural tourism development and the ecological environment, constructs two systematic index systems based on existing research results, and draws empirical research conclusions using coupling coordination models for quantitative analysis (dos Santos Sá et al., 2022). It summarizes the experience of enhancing the level of coupling coordination between rural tourism development and the ecological environment in Province A and proposes a strategic development direction based on empirical evidence (Akbar et al., 2022). This includes simultaneous

Figure 2. Annual Output of Rural Garbage in Province A



tourism economy development and ecological environment protection, along with a series of effective measures to mitigate pollution, as represented in Figure 2. Notably, waste production is showing a decreasing trend annually.

MATERIALS AND METHODS

Research Objects

70% of the tourism resources of Province A are in the countryside because of rich agricultural resources, colorful folk customs, vast rural tourism source market space, obvious location advantages, and convenient land and air transportation. These are significant rural tourism resources. Rural tourism exhibition industry development prospects are good, but they cannot be at the expense of the environment.

The Relationship Between Rural Tourism Development and Environmental Protection

The relationship between rural tourism development and environmental protection is complex and multifaceted, often requiring a delicate balance between economic growth and ecological sustainability. What follows is a detailed description of the relationship.

Rural tourism development and environmental protection are inherently interconnected. The success of rural tourism is often dependent on the preservation of the natural environment and cultural heritage that attract visitors in the first place. Environmental degradation, such as pollution or habitat destruction, can diminish the appeal of rural destinations and harm the tourism industry in the long run. Therefore, sustainable tourism practices that prioritize environmental conservation are essential for the continued success of rural tourism. While rural tourism can bring economic benefits to local communities, it can also contribute to environmental protection. By promoting eco-friendly practices, raising awareness about conservation issues, and supporting local environmental initiatives, rural tourism can play a role in preserving natural resources and biodiversity. In this sense, rural tourism development and environmental protection can mutually reinforce each other, leading to a symbiotic relationship whereby both sectors benefit from sustainable practices.

Balancing the priorities of rural tourism development and environmental protection requires careful consideration of both short-term economic gains and long-term ecological sustainability. While economic growth is important for local livelihoods and community development, it should not come at the expense of environmental degradation. Prioritizing environmental protection ensures the preservation of natural resources for future generations and maintains the integrity of rural landscapes that are essential for tourism. To manage the relationship between rural tourism development and environmental protection effectively, an integrated approach is needed. This involves incorporating environmental considerations into tourism planning and decision-making processes, implementing sustainable tourism practices, and engaging local communities in conservation efforts. By adopting a holistic approach that considers both economic and environmental factors, policymakers and stakeholders can achieve a balance that promotes sustainable rural tourism development while safeguarding the natural environment.

The relationship between rural tourism development and environmental protection is characterized by interdependence, mutual benefits, and the need for prioritization and balancing of priorities. By recognizing the intrinsic connection between tourism and the environment and adopting sustainable practices, rural destinations can achieve a harmonious coexistence whereby economic prosperity and ecological integrity go hand in hand.

Research Methods and Protocols

The literature research method is a research method that forms a new understanding after studying the literature on the basis of collecting and sorting out relevant literature in the field of research, which requires comprehensiveness and objectivity (Raj & Sharma, 2023). This study aims at the relationship between the development of rural tourism and the ecological environment in Province A through literature review and data collection, which paves the theoretical aspects for the in-depth discussion of this paper (Tien et al., 2024). In order to study the evolution of the environment under human activities, the PSR model was first proposed by Canadian statisticians Rapport and Friend and was adopted by the Organization for Economic Cooperation and Development. It is a classic evaluation model in the field of environmental quality assessment science, which has led to very good repercussions in this research field (Xu et al., 2022). In the PSR model, *P* represents the pressure index, which is used to describe the pressure carried by natural resources and ecological environment under the influence of human activities (Gao et al., 2023). *S* denotes state indicators, which describe the state and characteristics of the natural environment and ecosystems. *R* stands for response indicators, which describe the preventative measures of the government, society, and the public, restoration responses, and human actions that have a negative impact on the ecological environment (Sobhani et al., 2023). In short, the PSR model answers the three fundamental questions of sustainable development: what happened, why did it happen, and what to do in the future (He et al., 2023). The details are shown in Figure 3.

Coupling is a phenomenon in physics in which two or more systems interact with each other in various ways (Li et al., 2023b). Benign coupling means that the system or system elements can promote each other, and vice versa with bad coupling. The degree of coupling is usually used to measure the degree of interaction between the systems and their elements. Therefore, the degree of coupling can only reflect the degree of coupling between each system and its elements but cannot reflect whether this coupling is benign or bad coupling. Therefore, in this study, it is necessary to obtain the results of coupling coordination data and then clearly conclude the status of rural tourism and ecological environment. The aim is for the two to produce benign promotion and protect the ecological environment while developing rural tourism. The coupling coordination of this study is shown in Table 1 (Wang et al., 2023).

In addition to the PSR model, Genetic Algorithms (GAs) were employed to analyze the intricate relationship between rural tourism development and environmental protection in Province A. GAs are a type of optimization algorithm inspired by the process of natural selection and genetics. They are

Figure 3. PSR Basic Model Framework

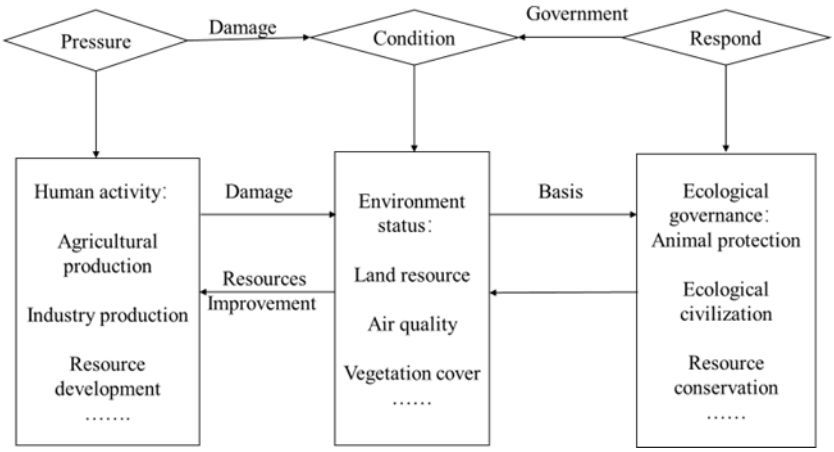


Table 1. Grade Standards for Coupling and Coordination Between Tourism Development and Ecosystem

Coupling coordination (D)	Coordination level	Coupling coordination (D)	Coordination level
0 ⩽ D<0.1	Extreme dysregulation	0.5⩽ D<0.6	Barely coordinated
0.1 ⩽ D<0.2	Severe dysregulation	0.6 ⩽ D<0.7	Junior coordination
0.2⩽ D<0.3	Moderate outrange	0.7 ⩽ D<0.8	Intermediate coordination
0.3⩽ D<0.4	Mild disorders	0.8 ⩽ D<0.9	Well-coordinated
0.4⩽ D<0.5	On the verge of imbalance	0.9⩽ D<1	Quality coordination

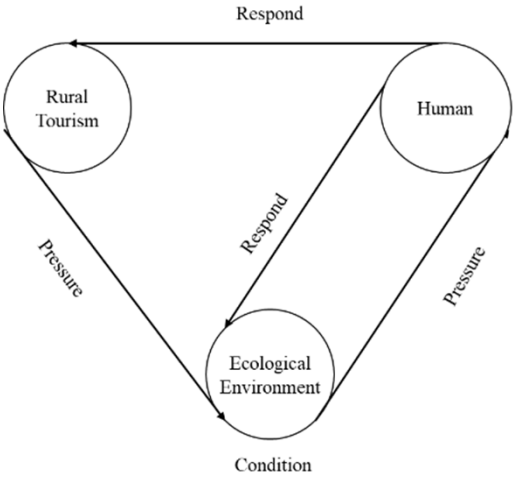
particularly well-suited for solving complex problems with multiple variables and objectives, making them a valuable tool for exploring the trade-offs between economic development and ecological sustainability.

The GAs utilized in this study navigated the complex problem space inherent in balancing economic growth with environmental conservation in rural tourism settings. By incorporating mathematical modeling and weight coefficient calculations, the GAs were able to assess the impact of tourism activities on the ecological environment and identify optimal strategies for promoting sustainable rural tourism development.

The algorithm incorporates data on tourism activities, environmental indicators, policy interventions, and community engagement to calculate the degree of coupling between the tourism economy and the ecological environment over time. Through iterative processes of selection, crossover, and mutation, the GAs explored different solutions and evaluated their fitness based on predefined criteria related to environmental protection and economic viability. By simulating the evolution of potential solutions over multiple generations, the GAs provided insights into the effectiveness of practices and policies aimed at achieving a harmonious balance between rural tourism development and ecological integrity.

The integration of GAs alongside the PSR model enhanced the analytical capabilities of the study, allowing for a more comprehensive assessment of the coupling dynamics between rural tourism economy and ecological environment. By leveraging the computational power and optimization capabilities of GAs, the study identified optimal pathways for promoting sustainable rural tourism practices while safeguarding the natural environment in Province A.

Figure 4. PSR Model of Rural Tourism and Ecological Environment



Research Contents

The most important characteristics of the coupling between rural tourism development and ecological environment are as follows: On the one hand, a good ecological environment is the basis for the healthy development of rural tourism industry; on the other hand, the quality of tourism development directly affects the quality of the ecological environment (Li et al., 2023c). If the tourism industry develops benignly, it can not only provide financial support for the protection and improvement of the ecological environment with the economic benefits obtained by tourism development, but it can also urge local governments to pay attention to the protection of the ecological environment in order to maintain a good momentum of development.

Coupling Coordination Mechanism PSR Framework

Without additional interference, as the rural tourism industry develops, its continuous expansion puts pressure on the ecological environment, and the ecological environment puts pressure on the industry as there is a need to restrict the development of tourism. On the other hand, improving the ecological environment can provide support for tourism development, and tourism development can feed back to the virtuous circle of the ecological environment, achieving systematic, coordinated, and continuous coupling and coordination between the two. The details are shown in Figure 4.

Evaluation Index System

The evaluation index system configuration employed in this study was designed to analyze the coupling dynamics between the rural tourism economy and the ecological environment in Province A comprehensively. The system integrated a set of evaluation indicators, data collection methods, and analytical tools to quantify the impact of tourism activities on environmental sustainability and economic development in rural areas. The equipment utilized for the test encompassed a mix of traditional field survey instruments, data logging devices, and advanced computational models tailored for the specific requirements of the study. While the individual components of the system configuration may not be considered groundbreaking in isolation, the innovative aspect lies in the strategic integration and application of these tools within the context of evaluating the rural tourism economy and ecological environment.

The equipment used for the test demonstrated a level of uniqueness in its tailored application to the study of the rural tourism economy and ecological dynamics in Province A. By combining

established evaluation indicators with innovative data analysis techniques such as the PSR model and coupling degree analysis, we were able to create a system configuration that offered a comprehensive and insightful assessment of the interplay between tourism development and environmental quality. The strategic integration and application of the system within the research context enables a nuanced understanding of the complex relationship between the rural tourism economy and ecological environment in Province A.

The PSR model in Figure 4 shows the relationship between the rural tourism economy and the ecological environment, and the following methods are used to apply and implement this model in practice. Firstly, the tourism economy module and ecological environment module are described in detail, and the corresponding evaluation results are obtained to judge the indicators. Let A_{ij} characterize the j_{th} indicator in the i_{th} module; T_{ij}^{1} and T_{ij}^{2} are the two thresholds used to judge the positive or negative value of the indicator A_{ij} influence value on the parent module. The value of the effect of the A_{ij} on the parent module is shown in Equation 1 (Gan et al., 2023):

$$Aij = \begin{cases} \dfrac{a_{ij} - T_{ij}^{1}}{a_{ij} - T_{ij}^{2}}, Aij \geq 0 \\ \dfrac{T_{ij}^{1} - a_{ij}}{a_{ij} - T_{ij}^{2}}, Aij < 0 \end{cases} \tag{1}$$

Secondly, the weight coefficient of the module is calculated. In the actual calculation process, because the unit dimensions of each index are often different, the variation method is generally chosen to calculate the weight. If a_i represents the mean of all values of the i_{th} indicator, and the standard deviation of all scoring data of the i_{th} index is expressed by σ_i, then the coefficient of variation of the indicator can be calculated according to Equation 2:

$$p_i = \frac{\sigma_i}{a_i} \tag{2}$$

After the coefficient of variation for all indicators is derived, the weight of the i_{th} indicator can be calculated, as shown in Equation 3:

$$\omega_i = \frac{p_i}{\sum_{i=1}^{m} p_i} \tag{3}$$

Therefore, the contribution degree of the i_{th} module is obtained, and the calculation method is shown in Equation 4:

$$F_i = \sum_{j=1}^{n} p_i A_{ij} \tag{4}$$

Finally, by analyzing the two modules, the coupling degree between the two modules is obtained, as shown in Equation 5:

Table 2. Ecological Environment and Tourism Economic Indicators

Symbol	Belongs to the module	Module metrics
X_1	Rural tourism economy	Number of domestic tourists in rural areas of Province A
X_2	Rural tourism economy	Number of international visitors in rural areas of Province A
X_3	Rural tourism economy	Total tourism revenue from rural areas of Province A
X_4	Rural tourism economy	Province A rural area tourism foreign exchange input
Y_1	Ecology	Area of green space in rural areas of Province A
Y_2	Ecology	Total sewage discharge in rural areas of Province A
Y_3	Ecology	Total amount of waste emissions from rural areas of Province A
Y_4	Ecology	Total solid waste discharge in rural areas of Province A
Y_5	Ecology	Folklore conditions in rural areas of Province A
Y_6	Ecology	Number of featured tourist attractions in rural areas of Province A

$$C = 2\sqrt{\frac{F_1 \cdot F_2}{\left(F_1 + F_1\right)^2}} \tag{5}$$

In the formula, F_1 represents the rural tourism economy module, and F_2 represents the ecological environment module.

According to the PSR model, the indicators of the ecological environment module and the rural ecotourism economy module are further refined, and the indicators set for the ecological environment and tourism economy in this paper are shown in Table 2 according to the actual situation of Province A.

To analyze the priority and performance metrics of the rural tourism economy and the ecological environment, a combination of indicators and weights were used to calculate these metrics. What follows are some equations that were used to calculate priority and performance metrics for the rural tourism economy and the ecological environment.

Priority Metric Equation

The priority metric can be calculated based on the importance or significance of certain indicators in the rural tourism economy or ecological environment. One way to calculate the priority metric is by considering the weighted sum of individual indicators. The equation for the priority metric (P) can be represented as

$$P = \sum_{i=1}^{n} w_i \times I_i \tag{6}$$

where *P* is the priority metric, w_i is the weight assigned to indicator i, I_i is the value of indicator i, and n is the total number of indicators.

Identify key indicators for the rural tourism economy and the ecological environment. These indicators could include factors like tourist arrivals, revenue generated from tourism, biodiversity index, air quality index, and more. Assign weights to each indicator based on their importance or significance in the context of the study. Calculate the priority metric using the weighted sum of indicators.

Performance Metric Equation

The performance metric assesses how well the rural tourism economy or ecological environment is performing based on specific criteria. One common approach is to calculate a composite performance index using normalized values of individual indicators. The equation for the performance metric (*PM*) can be expressed as

$$PM = \frac{1}{n}\sum_{i=1}^{n} \frac{I_i - \min\left(I\right)}{\max\left(I\right) - \min\left(I\right)} \times 100 \tag{7}$$

where PM is the performance metric, I_i is the value of indicator, $\min\left(I\right)$ is the minimum value of all indicators, $\max\left(I\right)$ is the maximum value of all indicators, and n is the total number of indicators.

Normalize the values of indicators to a common scale (for example, between 0 and 1) to account for differences in measurement units. Calculate the performance metric using a composite index formula.

In conclusion, calculate the priority metric for both the rural tourism economy and the ecological environment using the assigned weights and indicator values. Calculate the performance metric for each indicator and then aggregate them to obtain an overall performance metric for the rural tourism economy and the ecological environment. Compare the priority and performance metrics over time or across different scenarios to assess the relationship between rural tourism development and environmental sustainability. By following these steps and equations, we can analyze the priority and performance metrics of the rural tourism economy and the ecological environment, providing valuable insights into their interplay and impact on sustainable development in Province A.

Data Logging

On this basis, the PSR model, the coupling degree analysis method. and the evaluation indicators constructed in Table 2 were used to analyze the tourism economy and ecological environment of rural areas of Province A. In terms of timeline, the relationship between rural tourism economy and ecological environment in Province A was studied, and we started in 2005 and ended in 2018. The relevant data in these 14 years were collated, and they were calculated using Equation 1 to Equation 5, especially the calculation of coupling degree, as shown in Table 3.

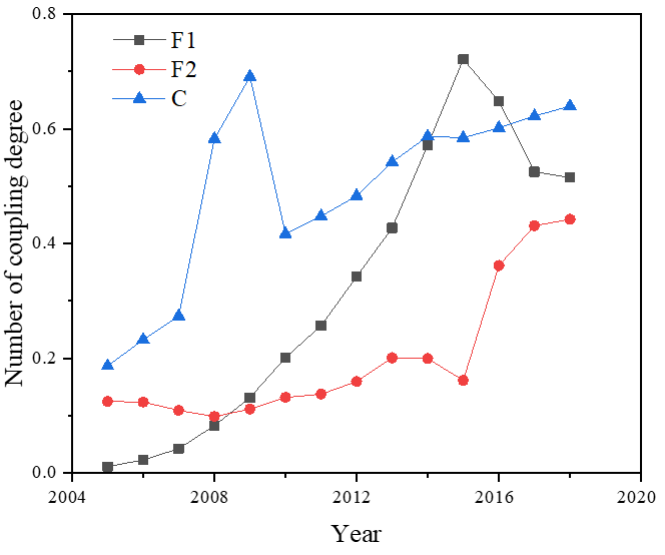
In order to more clearly reflect the coupling trend of rural tourism and ecological environment in Province A, the data in Table 3 is depicted in Figure 5.

To justify the degree of coupling obtained compared to Min Max values, we need to define the Min Max values for the coupling degree. In this case, the Min Max values represent the minimum

Table 3. Analysis of the Coupling Degree of the Relationship Between Tourism Economy and Ecological Environment

Annual	F_1	F_2	Degree of coupling	Coupling type	Remark
2005	0.0114	0.1249	0.1868	Extreme dysregulation	The economy is extremely lagging
2006	0.0231	0.1239	0.2325	Moderate outrange	The economy is extremely lagging
2007	0.0425	0.1094	0.2738	Moderate outrange	The economy is extremely lagging
2008	0.0829	0.0988	0.5827	Barely out of balance	The economy is lagging behind
2009	0.1315	0.1116	0.6912	Junior coordination	The economy generally lags behind
2010	0.2014	0.1320	0.4169	On the verge of imbalance	Environmental Neutral Lag
2011	0.2569	0.1377	0.4477	On the verge of imbalance	Environmental Neutral Lag
2012	0.3424	0.1596	0.4833	On the verge of imbalance	Environmental Neutral Lag
2013	0.4273	0.2009	0.5421	Barely coordinated	The environment is lagging
2014	0.5719	0.1997	0.5870	Barely coordinated	The environment is lagging
2015	0.7213	0.1616	0.5846	Barely coordinated	The environment is lagging
2016	0.6484	0.3617	0.6017	Junior coordination	The environment generally lags
2017	0.5251	0.4313	0.6224	Junior coordination	The environment generally lags
2018	0.5149	0.4424	0.6398	Junior coordination	The environment generally lags

Figure 5. SR Frame Coupling Curve



and maximum possible values for the degree of coupling. From Table 3, we can observe that the degree of coupling ranges from 0.1868 to 0.6912. To determine the Min Max values, we need to identify the lowest and highest values within this range. The minimum value within the observed range is 0.1868, which corresponds to the extreme dysregulation of the coupling between the tourism economy and ecological environment. This value represents the lower limit of the coupling degree. The maximum value within the observed range is 0.6912, which corresponds to the junior coordination of the coupling between the tourism economy and ecological environment. This value represents the upper limit of the coupling degree.

Therefore, based on the data provided in Table 3, the Min Max values for the degree of coupling are 0.1868 (minimum) and 0.6912 (maximum). By comparing the obtained degree of coupling values in the table to these Min Max values, we can assess the level of coupling. For example, a value of 0.5827 indicates that the coupling is barely out of balance, while a value of 0.6017 suggests junior coordination. This analysis allows us to contextualize the degree of coupling obtained in the study within the broader range of possible values and understand the relative strength or weakness of the coupling relationship between the tourism economy and ecological environment in each year.

RESULTS AND DISCUSSION

The study's application of the Pressure-State-Response (PSR) model, enhanced by the integration of Genetic Algorithms (GAs), provided a structured and innovative approach to examining the interplay between rural ecotourism and environmental protection in Province A. Through meticulous analysis using tailored indicators and mathematical modeling, the research yielded significant insights into the dynamics governing the relationship between the rural tourism economy and the ecological environment. The evaluation of indicators within the tourism economy and ecological environment modules, based on Equations 1 to 4, facilitated a nuanced understanding of their respective impacts. The calculation of weight coefficients underscored the varying significance of different indicators, highlighting areas of priority for both economic development and environmental sustainability. The coupling degree analysis, conducted via Equation 5, revealed the interaction level between the rural tourism economy and the ecological environment. This analysis was pivotal in assessing the balance or imbalance present in Province A's context, providing a quantitative basis for further strategic planning and intervention. The innovative application of GAs for objective function optimization represented a forward-thinking approach to navigating the complex, multi-dimensional problem space inherent in balancing rural tourism development with ecological sustainability. Steps ranging from the formulation of the objective function to the iterative process of selection, crossover, mutation, and termination offered a systematic method for exploring potential solutions.

Based on the evaluation of the coupling dynamics between the rural tourism economy and the ecological environment in Province A using the established evaluation index system configuration, the following results and conclusions can be drawn.

Evaluation Results

Priority Metric Analysis

The priority metric analysis highlighted key indicators that are crucial for the sustainable development of rural tourism and environmental conservation in Province A. By assigning weights to these indicators, the study identified areas of focus for policymakers and stakeholders to enhance the coupling between tourism development and ecological protection.

Performance Metric Analysis

The performance metric analysis provided insights into the current state of the rural tourism economy and the ecological environment in Province A. By calculating composite indices based on normalized

indicator values, the study assessed the overall performance of both sectors and identified areas of strength and improvement (Kang & Lee, 2024).

Coupling Degree Analysis

The coupling degree analysis revealed the level of coordination between the rural tourism economy and the ecological environment over the study period. By tracking the changes in coupling degree values, the research highlighted trends in the relationship between tourism development and environmental sustainability in Province A.

Future Work

This research opens up avenues for future studies to delve deeper into specific indicators, refine the application of Genetic Algorithms, and explore the implications of different policy scenarios. Continuous monitoring and adaptive management, informed by ongoing research, will be essential in navigating the challenges and opportunities presented by rural ecotourism development and environmental protection. The findings from this study underscore the complex and dynamic relationship between rural ecotourism development and environmental protection, as analyzed through the lens of the PSR model and augmented by the strategic use of Genetic Algorithms.

Longitudinal Analysis

Future research could focus on conducting a longitudinal analysis to track the evolution of the coupling dynamics between rural tourism and the ecological environment in Province A over an extended period. This would provide valuable insights into the long-term trends and patterns of interaction between these two domains.

Policy Implications

Further studies could explore the policy implications of the research findings and recommend strategies for enhancing the coordination between rural tourism development and environmental protection in Province A. This could involve proposing targeted interventions and measures to promote sustainable tourism practices and conservation efforts.

Stakeholder Engagement

Future work could involve engaging with local communities, government agencies, and tourism stakeholders in Province A to gather qualitative insights and perspectives on the challenges and opportunities related to rural tourism and ecological sustainability. This participatory approach could enrich the understanding of the complex dynamics at play.

Advanced Modeling Techniques

Leveraging advanced modeling techniques such as machine learning algorithms or spatial analysis tools could enhance the predictive capabilities of assessing the impact of tourism activities on the ecological environment in Province A. By incorporating cutting-edge methodologies, future research could provide more accurate forecasts and scenario analyses.

In conclusion, the evaluation results from the study shed light on the intricate relationship between rural tourism economy and ecological environment in Province A, offering valuable insights for sustainable development planning and conservation efforts. Future work in this area could deepen our understanding and contribute to the formulation of effective strategies for promoting harmonious coexistence between tourism development and environmental protection.

CONCLUSION

By integrating the PSR model and GAs, this study has undertaken a thorough examination of the intricate relationship between rural ecotourism development and environmental protection in Province A. The analysis of key indicators within the tourism economy and ecological environment domains has yielded nuanced perspectives on the environmental impact of rural tourism and strategies for sustainable management. The assessment of the coupling degree has underscored the delicate equilibrium between economic progress and ecological preservation, offering a quantitative foundation for evaluating existing approaches. Leveraging Genetic Algorithms strategically has showcased the potential for innovative solutions to optimize rural tourism while safeguarding the environment.

The implications of this research extend significantly to policymakers, tourism stakeholders, and environmental advocates by presenting a systematic framework to enhance sustainability in rural ecotourism. The imperative task of balancing economic prosperity with environmental conservation demands a data-informed approach, facilitated by the synergy between the PSR model and GAs. Continuous exploration and policy innovation are vital to ensure that rural tourism evolves without compromising ecological integrity.

Although the focus of this study is on Province A, the principles of the PSR model and coupling coordination mechanism are transferable to other provinces or regions with burgeoning rural tourism sectors. By comprehending the intricate interplay between tourism expansion and environmental preservation, policymakers across diverse locales can tailor strategies to suit their unique circumstances. The evaluation index system and the established PSR model from this research can serve as a blueprint for evaluating the nexus between rural tourism and the ecological environment in various provinces. Customizing the methodology to local contexts enables researchers to glean insights into the sustainability of rural tourism development across different regions.

DATA AVAILABILITY

The figures and tables used to support the findings of this study are included in the article.

CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest.

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