

## Rational utilization of water resources to promote sustainable development of rural ecotourism

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### ABSTRACT

Today's society is grappling with a critical issue: how to sustainably expand rural ecotourism and make good use of water resources (the following expressions are all denoted by WRs). This paper has analyzed the characteristics of rural ecotourism based on the current situation of WR utilization, starting from the meaning of rural ecotourism, and has taken three tourist villages for research on the utilization of WRs. The results indicated that the WRs used in the tourism industry in rich villages in 2019 accounted for the highest proportion (28.81%) between 2010 and 2019; medium villages reached a maximum of 18.32% in 2017; poor villages in 2014 used the highest proportion of WRs in the tourism industry between 2010 and 2019, accounting for 37.76%. Poor villages have consistently spent the largest amount of water in the tourism industry. It showed that blindly utilizing WRs in the tourism industry could not promote economic development, only rational distribution could achieve sustainable economic growth and sustainable development of tourism ecology. This paper has also discussed the problems of water utilization in rural ecotourism development using this research and provides corresponding solution strategies, hoping to provide a theoretical reference for the sustainable development of rural ecotourism.

**Key words:** rational utilization, rural ecotourism, sustainable development, water resources

### HIGHLIGHTS

- This paper analyzes the characteristics of rural ecotourism.
- Poor villages have been spending the most water on tourism.
- The problems of water resource utilization in the development of rural ecotourism are discussed.
- Put forward the corresponding water resources management strategy.
- It has a certain reference value for rational utilization of water resources.

## 1. INTRODUCTION

The demand for tourism has been steadily rising since the reform and opening up along with the growth of the economy, and diverse consumer wants can no longer be satisfied by traditional agriculture. Therefore, rural ecotourism develops rapidly (Liang & Shi 2020). People are yearning for slower-paced country living more and more as urban life speeds up. For tourists to experience rural scenery, a new form of tourism called rural ecotourism has evolved. It is vital to do a thorough examination of the planning of rural ecotourism in order to assure its sustainable development. At the same time, many regions have launched rural ecotourism projects to attract tourists to spend, so as to drive local economic development. Rural ecotourism is an ecotourism mode developed in rural areas by utilizing rural natural resources and combining the development concept of modern tourism economy. It takes rural landscape and agricultural resources as tourist attractions, rural leisure and agricultural experience as main contents and develops rural tourism products with local characteristics on the basis of protecting local ecological environment. In the development of rural ecotourism, rational utilization of WRs has become an important issue. WRs must be addressed for sustainable development to be achieved. This paper depicts the problems of WR utilization from the meaning of sustainable development of rural ecotourism and illustrates several strategies to promote sustainable development of rural ecotourism by rational utilization of WRs.

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The development of tourism industry can effectively promote regional economic gross value and has a non-negligible role in building society. Therefore, many scholars express their research on it. Tonino Pencarelli believed that the tourism ecosystem and regions could not only consider digital innovation and they must include intelligent tourism perspectives including sustainable development and recycling economy (Pencarelli 2020). Carlos Peixeira Marques said there has been a significant increase in preference for rural tourism and that those areas best suited for rural accommodation have experienced a stronger and sustained recovery in demand (Marques *et al.* 2022). Bogdan Sofronov held that tourism could promote economic growth, create jobs, promote social development and promote peace (Sofronov 2018). Xu Xu believed that celebrity endorsement was a proven marketing strategy that could also work well in the tourism sector (Xu & Pratt 2018). Dean Creevey proposed a new phase in the journey (Creevey *et al.* 2019). Sudipta Kiran Sarkar attempted to study the evolving dynamics of social media driving sustainable tourism (Sarkar & George 2018). Chin Chee-Hua stated that green tourism and green marketing were alternative practices to ensure environmental sustainability in tourist destinations (Chin *et al.* 2018). As tourism industry continues to develop, rural ecotourism is gradually revitalized and increasing travelers are focusing on rural ecotourism to experience the fresh air and slow-paced living environment.

Rural ecotourism has gradually emerged as a popular issue in the tourism industry, attracting many scholars to study it. Soofia Abbasi said that ecotourism entrepreneurship was considered a strategy for sustainable rural development and creating jobs through sustainable utilization of local resources (Abbasi *et al.* 2022). Iwan Nugroho studied social capital and social capabilities to enhance ecotourism in rural areas (Nugroho *et al.* 2021). Stephen Schweinsberg said that many of the world's iconic ecotourism attractions were located in heterogeneous rural areas (or places) (Schweinsberg *et al.* 2018). Soroush Khalili found that due to the diversity and cultural and natural potential of rural areas, developing ecotourism was considered a key solution to sustainable rural development (Khalili *et al.* 2020). Reza Sepahvand research not only provided strategies and helpful tips for planning rural ecotourism, but also enriched the literature of ecotourism, promoted education, and introduced the culture and attractions of the village (Sepahvand *et al.* 2018). Ana-Elia Ramon-Hidalgo examined two aspects of social capital in a community-based rural ecotourism project as they related to social differences and political empowerment (Ramon-Hidalgo & Harris 2018). With the increasing shortage of WRs, rural ecotourism cannot leave rational utilization of WRs if it wants to achieve sustainable development. Therefore, this paper studies it.

In this paper, the promotion of sustainable development of rural ecotourism based on the rational utilization of WRs is studied and a questionnaire survey on rural ecotourism is conducted based on the rational utilization of WRs. The survey results suggest that 1,111 tourists expressed their preference to rural ecotourism. Another 896 people expressed their willingness to support the development of rural ecotourism. 1,173 people expressed irrational opinions on whether the utilization of WRs was rational or not, and another 1,142 people thought that the rational utilization of WRs could promote the sustainable development of rural ecotourism. It shows that the study on rational utilization of WRs has certain practical significance to promote sustainable development of rural ecotourism.

## 2. OVERVIEW OF RURAL ECOTOURISM

In recent years, China's tourism industry has been growing upward at an annual rate of more than 20%, contributing to the country's economic development. The reasons for the sustained growth of China's tourism industry can be attributed to the following aspects: economic development and increased income levels: With the rapid development of the Chinese economy, people's income levels have generally increased, and people's tourism demand has gradually increased. Tourism has become an important form of leisure consumption, and people are more willing to spend on it. Support for tourism policies: The Chinese government actively introduces tourism promotion policies to encourage and support the development of the tourism industry. The policy facilitation and incentive measures have attracted more investment and participants, promoting the rapid growth of the tourism industry. Improvement of transportation infrastructure: China's transportation infrastructure is constantly improving, and the development of transportation modes such as highways, high-speed railways, and aviation has made people's travel more convenient and efficient, greatly promoting the development of the tourism industry. Meanwhile, owing to the unique geographical location and superior resources such as local conditions and human relations, a large number of tourists are attracted to go to rural tourism for sightseeing and consumption, and rural ecotourism has been fully developed. Rural ecotourism is a form of tourism that is based on the natural environment, ecological resources, and cultural traditions of rural areas, combined with the characteristics of tourism development. Through activities such as tourism and leisure vacation, it promotes rural economic development, improves farmers' lives, and protects and improves

the quality of the ecological environment. To a certain extent, this new type of tourism can improve the environmental pollution problems and effectively promote the development of local economy. In the development of rural ecotourism, it is advisable to take sustainable development as the goal and actively protect local natural resources and environment. When developing rural ecotourism, it is important to implement appropriate development models based on the geographical characteristics of different areas and different types of tourism resources.

### 3. RELEVANT OVERVIEW OF WRS

#### 3.1. Existence mode of WRS

##### 3.1.1. Natural circulation of WRs in rural environment

WRs are an important material basis for human survival and development, and human activities depend on WRs regulated by climate (Adu 2018). WRs exist in nature in the form of natural circulation, so in the rural natural environment, water also circulates as it does in nature, a natural cycle process from liquid to gas to liquid, and in the rural natural environment, because the land and fresh WRs exist in the rural environment are natural, more abundant than in the town. Therefore, the natural basic conditions for the recycling of WRs are formed. Meanwhile, the circulation movement of WRs is also a necessary condition for maintaining the rural ecological environment. Figure 1 shows the natural circulation process of WRs in the rural environment. With the continuous development of rural ecotourism industry, it has a partial impact on the circulation of WRs in nature.

##### 3.1.2. Dynamic circulation of WRs in rural environment

Of course, although the development of rural ecotourism industry has caused a certain impact on the natural cycle of WRs, under human intervention, WRs and rural environment form a social cycle suitable for human activities. Such a cycle not only guarantees the recycling of WRs, but also makes rural ecotourism achieve good benefits. The importance of WRs to human beings is incomparable. Rational utilization of WRs can not only guarantee the natural cycle of WRs, but also realize the sustainable development of rural ecotourism, and achieve win-win cooperation between the two. The natural cycle of WRs and its dynamic cycle in the rural environment are independent and related. Figure 2 reflects the dynamic cycle of WRs in the rural environment. With the development of economy and society, the shortage of WRs becomes increasingly prominent. WR management for sustainable development also presents many challenges (Sheffield 2018).

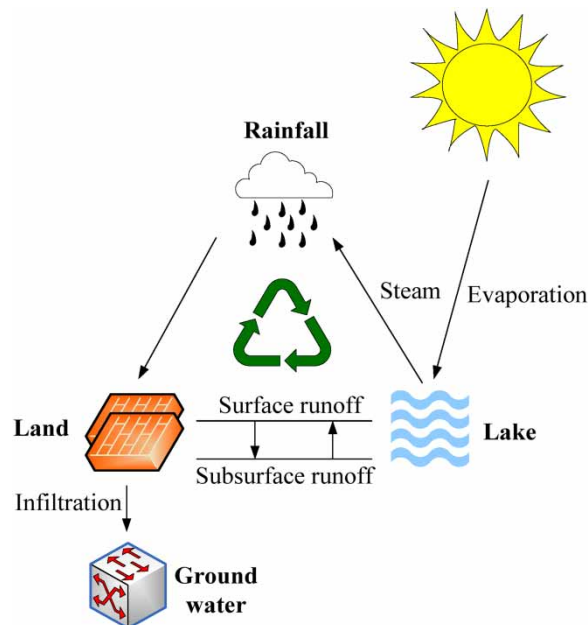
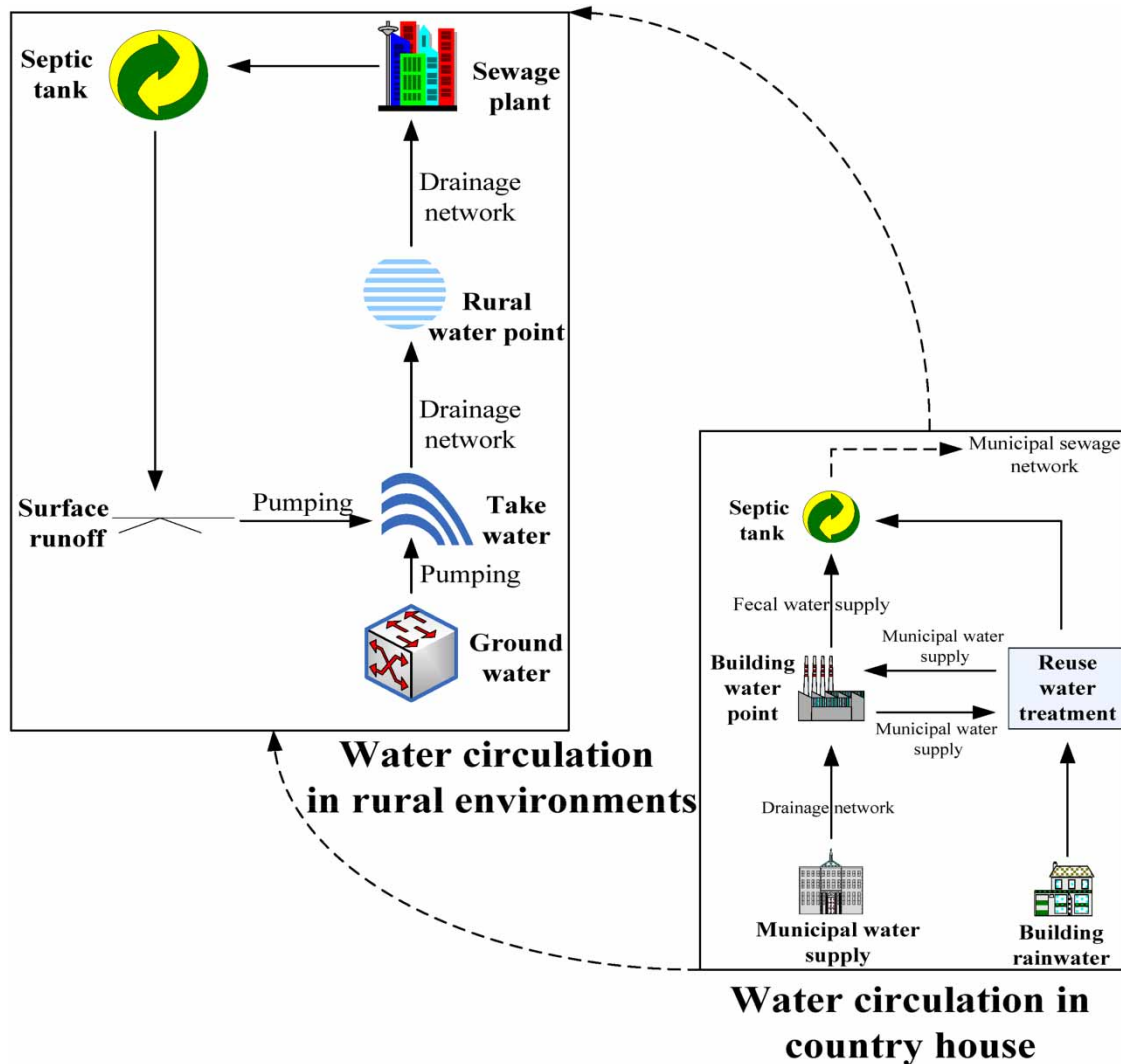


Figure 1 | Natural cycle of water resources.



**Figure 2** | Dynamic cycle process of water resources in rural environment.

### 3.2. Current situation and problems of WR utilization

From the current economic development of China, tourism has been a key industry in China, but WRs are a significant bottleneck during the development of the tourism industry. At present, China's utilization of WRs is not optimistic. In terms of water utilization rate, China's per capita water possession is less than half of the world's per capita and even far less than a quarter of the world's per capita, and most of China's regions are in water-scarce areas. Most of China is in water shortage areas. At the same time, groundwater resources in China are also facing serious shortage, and WRs are wasted seriously in many areas. On the one hand, these problems arise because the local government, residents and enterprises do not protect WR, resulting in serious pollution. On the other hand, a large amount of wastewater is discharged into the river for tourism development, which causes great pollution to WR. This has not only caused harm to the local residents, but also caused serious damage to the local environment. At present, the environmental pollution in China is becoming more and more serious, which leads to water pollution in many areas of China and seriously affects people's daily life.

According to relevant surveys, when developing tourism resources, many places tend to build some buildings with local characteristics so as to meet the needs of tourists. For example, some agritainment and folk museums are built in some places. However, there are serious waste phenomena in these buildings, and the waste of the WR is also very serious. Especially in the construction of farm delights, the original local vegetation and rivers are often destroyed, and some places may build some artificial lakes as tourist attractions. However, these artificial lakes are not polluted by external factors

in normal time, but during the peak season, a large number of tourists may rush into swim and fish, which directly leads to serious pollution problems in the water body, having a certain impact on local residents and tourists.

Therefore, at present, there are many irrational points in the utilization of WRs in society. The unbalanced utilization of WRs is due to the insufficient allocation of WRs and the failure to comply with the principle of rational allocation of WR. According to the principle of rational allocation of WR, the target measurement shall meet the calculation standard of the three principles at the same time.

Assuming different water consumption of rural users is  $W$ , if only the benefit of water to tourism economy and rural tourism environment is considered, the water consumption target can be measured as the basic target value with the maximum benefit, which can be expressed as:

$$O_{V1} = \max \sum_n F^n(E_n W_n) \quad (1)$$

Among them,  $O_V$  represents the value of the objective function;  $n$  indicates the number of rural water users;  $E$  represents water efficiency coefficient;  $F$  represents the benefit function relationship generated by water consumption. The benefit function relationship refers to the impact of different variables on specific interests in a specific context. It describes the mathematical relationship between various factors in a system or decision problem and the ultimate benefits achieved. The benefit function relationship can help understand the various factors that affect the realization of benefits and serve as the basis for decision analysis. If the principle of equitable distribution of water consumption among different villages or different rural residents' incomes need to be considered, then Formula (1) can be transformed:

$$O_{V2} = \max \sum_n C_n F^n(E_n W_n) \quad (2)$$

Among them,  $C$  means the fairness weight or fairness coefficient, and if:

$$C_p > \frac{C_r}{C_l} > C_h \quad (3)$$

Among them,  $C_p$  refers to poor village;  $C_r$  refers to rich village;  $C_l$  refers to low-income rural residents;  $C_h$  refers to high-income rural residents.

If the influence of time is taken into account,  $W$ ,  $E$ , and  $C$  are considered to vary with time  $t$ , then:

$$O_{Vt} = \max \sum_n C_{n,t} R^n(E_{n,t} W_{n,t}, t) \quad (4)$$

Among them,  $R$  represents the corresponding functional relationship.

Although the water consumption and correlation coefficient of each water user in the village may change with time and the comprehensive benefits vary greatly, sustainable development can only be realized if the principle of sustainable development is guaranteed and the water consumption benefit of future generations is not less than that of the previous generation. The connotation of the principle of sustainable development is to seek balance and coordination in the three aspects of economy, society, and environment. It emphasizes not only meeting current needs, but also considering the needs of future generations, without damaging the environment or sacrificing social justice, while achieving economic prosperity and social well-being. Only by following the principle of sustainable development can we achieve harmonious coexistence between humans and nature, ensure that the water efficiency of future generations is not lower than that of the previous generation, and achieve sustainable development. That is:

$$O_{Vt+1} \geq O_{Vt} \quad (5)$$

Alternatively, it is expressed as:

$$O_{V3} = \max \sum_n \left( \left( \sum_n C_{n,t} R^n (E_{n,t} W_{n,t}, t) \right) - \sum_n C_{n,t+1} R^n (E_{n,t+1} W_{n,t+1}, t+1) \right) \quad (6)$$

However, in real life, affected by the rapid development of human society and economy, human beings are always excessively pursuing economic benefits of  $O_{V1}$ . The research of  $O_{V2}$  is not deep and the demand of  $O_{V3}$  has not been taken into account, resulting in a situation that  $O_{Vt+1}$  is smaller than  $O_{Vt}$  in reality, which leads to irrational utilization of WR, serious deterioration of the environment and violates the principle of sustainable development.

#### 4. RELATIONSHIP AMONG SUSTAINABLE DEVELOPMENT, RATIONAL UTILIZATION OF WRS AND RURAL ECOTOURISM

From a macro perspective, the relationship between rural ecotourism and WRs is mutually reinforcing. The development of rural ecotourism can promote the optimization and upgrading of the local agricultural industry structure and also drive the local economic development. Rural ecotourism is of great significance to the utilization of WRs.

The rational utilization of WRs can contribute to the sustainable development of rural ecotourism, and ensuring sustainable development is also a way to achieve the protection of WRs. The purpose of making the relationship map as a smiley face in this paper is to express a good vision that sustainable development can be realized by rational utilization of WRs, which is also beneficial and harmless to human beings.

At present, an important feature of Chinese social and economic development is that economic development and environmental protection cannot coordinate with each other. As people's awareness of environmental protection continues to increase and more attention is paid to environmental protection, it is important for the tourism industry to adhere to the principle of sustainable development and the concept of green environmental protection. Therefore, in rural ecotourism, it is necessary to establish awareness of environmental protection and recycling of resources, not only focus on immediate interests but ignore long-term interests. Furthermore, the principle of sustainable development must be insisted on during rural ecotourism development in order to achieve healthy and sustainable development of the local economy. In the specific implementation process, scientific planning and rational layout should be made to ensure the rational utilization of local rural ecotourism and WRs.

First of all, the local WRs should be well protected. During the development of rural ecotourism, the local WR environment should be effectively protected to avoid damaging the local WR environment due to over-development. The management of WRs in rural ecotourism areas should be strengthened and the water quality of local waters should be effectively controlled. Second, the local environmental protection should be strengthened. For rural ecotourism areas, the ecological environment should be well protected, and the number of tourists should be controlled within a certain range. Thirdly, in order to effectively control the water quality in rural ecotourism areas, the following measures can be taken: establish a monitoring system: set up water quality monitoring points, and regularly monitor and evaluate the water area. Monitoring includes water quality indicators, Eutrophication degree, harmful substance content, etc. By understanding the water quality situation in real-time, problems can be identified early and corresponding prevention and control measures can be taken. Strengthen pollution control: Strictly control the discharge of sewage in rural tourism areas. Establish sound sewage treatment facilities and strengthen supervision over tourism enterprises and residents. For units that do not meet emission standards, penalties should be imposed, and efforts should be made to improve their pollution behavior. At the same time, encourage the use of environmentally friendly toilets and renewable water technology to reduce the impact of sewage on the water environment. Finally, relevant departments should also strengthen the supervision and management of rural ecotourism so as to guarantee the sustainable development of local rural ecotourism and WR.

#### 5. EXPLORATION ON THE UTILIZATION OF WRS IN RURAL ECOTOURISM

##### 5.1. Utilization of WRs in rural ecotourism

In this paper, three tourism villages were randomly selected as experimental samples, and WR utilization of these three villages were investigated. The WR utilization of the villages during the 10 years from 2010 to 2019 were, respectively, studied and analyzed from three aspects: agricultural water use, residential water use and tourism industry water use. These three



tourist villages differ in their affluence, referring to the rich, medium, and poor villages, respectively. The three rural tourism cities, respectively, refer to Zhangjiajie in Hunan Province, Pangu Town in Guilin and Yiqi Mountain in Baoding, Hebei Province.

Figures 3–5 are, respectively, the water consumption for agriculture, residents, and tourism industry in three tourism villages.

The X-axis represents the year; the Y-axis represents the percentage of water used in rural agriculture as a percentage of all WR; three series represent rich, medium, and poor villages.

From the data in Figure 3, it can be seen that different villages had different ratios of water for agriculture. The proportion of water used in agriculture in rich villages was increasing with the increase of years, presenting a positive growth rule, while the medium and poor villages do not have obvious laws to follow. In 2010, the annual water consumption of rich, medium, and poor villages accounted for 18.93, 11.25, and 8.14% of the total annual water consumption of their respective villages, respectively. In 2019, the annual water consumption of the three Tourism Villages accounted for 26.61, 15.33, and 10.68% of the total annual water consumption of their respective villages, respectively. It can be found that after 10 years of change, the rich village were still rich and still had the highest water allocation in agriculture, while the poor villages were poor because they did not develop agriculture vigorously.

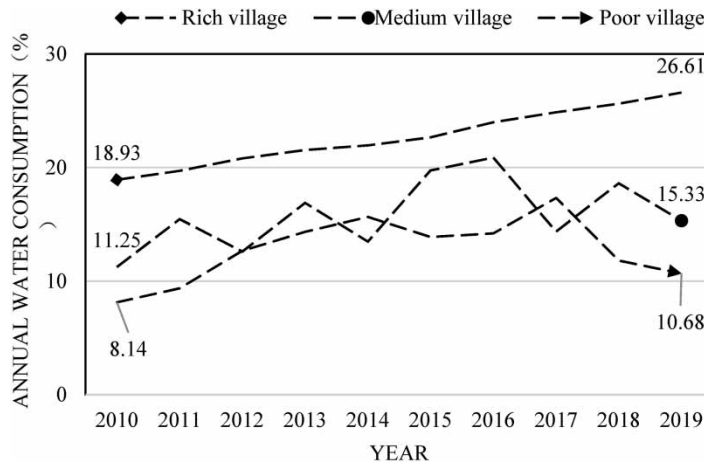


Figure 3 | Agricultural water consumption in tourism villages.

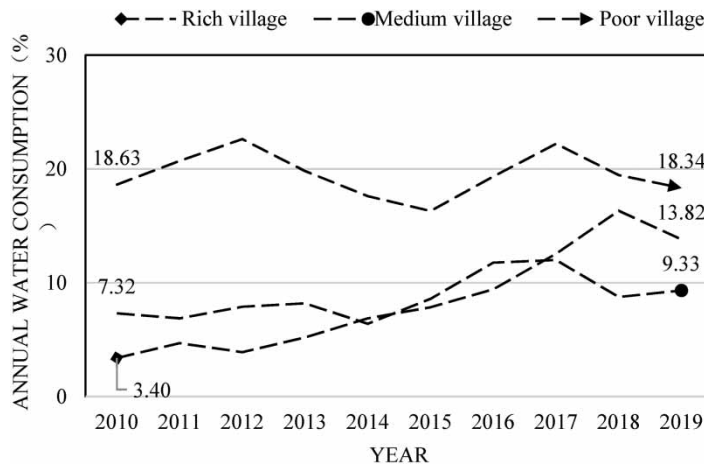
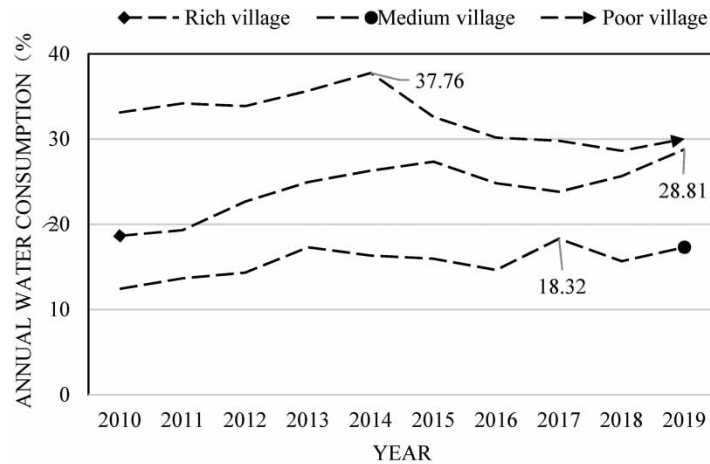


Figure 4 | Resident water consumption in tourism villages.



**Figure 5** | Water consumption of tourism industry in tourism villages.

The X-axis represents the year; the Y-axis represents the percentage of water used in daily life as a percentage of all WR; three series represent rich, medium and poor villages.

Figure 4 shows the water consumption of residents in three tourism villages. According to the observation in Figure 4, it can be found that there was no general rule in terms of water consumption for residents in all three villages. However, in 2010, the proportion of water consumption used by residents in rich, medium, and poor villages was 3.4, 7.32, and 18.63%, respectively. In 2019, the proportion of water consumption used by residents in rich, medium, and poor villages was 18.32, 9.33, and 18.34%, respectively. It can be seen that both rich and medium villages had a certain increase in water consumption for residents, while only poor villages had a slight decrease.

The X-axis represents the year; the Y-axis represents the percentage of water used by the rural tourism industry as a percentage of all WR; three series represent rich, medium, and poor villages.

According to the observation in Figure 5, it can be found that the WRs used in the tourism industry in the rich village in 2019 accounted for the highest proportion in 10 years, 28.81%. In 2017, the WRs used by the medium village in the tourism industry accounted for the highest proportion (18.32%) in 10 years. The poor village in 2014 used the highest proportion of WRs in the tourism industry in 10 years, accounting for 37.76%. The poor village had consistently spent the largest amount of water in the tourism industry.

Combining the data of Figures 3–5, it can be found that although poor villages consume most WRs in the tourism industry, the economy of poor villages was still the worst. The utilization of WRs in the tourism industry did not promote the economic benefits of poor villages. On the contrary, the WR distribution in rich villages is more rational. Rich villages vigorously developed agriculture, improved greening and ecology and unexpectedly promoted the local tourism situation. From this point of view, the distribution of WRs was very important to rural ecotourism, and the rational utilization of WRs had a positive impact on the sustainable development of rural ecotourism.

## 5.2. Questionnaire survey

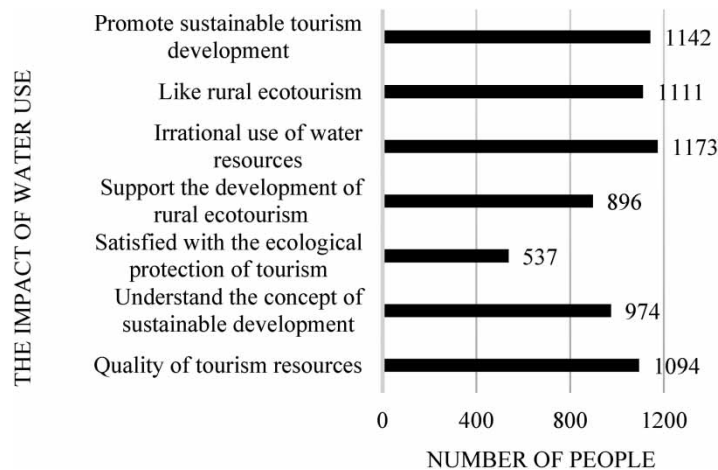
### 5.2.1. Questionnaire reliability

In order to truly reflect the impact of WR utilization on the sustainable development of rural ecotourism, this paper carried out a questionnaire survey for 1,273 residents and tourists in three villages. 1,500 questionnaires were sent out, where 1,321 questionnaires were recovered and 48 questionnaires were deleted. Its recovery rate is 88%. Therefore, 1,273 questionnaires were finally included in the statistics. The results of the questionnaire were analyzed by SPSS (Statistical Product and Service Solutions) software and the Cronbach's alpha  $\alpha$  was selected as a reliability coefficient. The reliability coefficient of this questionnaire is 0.92, which indicated that the questionnaire had a good reliability.

### 5.2.2. Questionnaire results

This questionnaire investigated whether the utilization of WRs by residents and tourists has an impact on the sustainable development of rural ecotourism. Some representative surveys were selected as shown in Figure 6 (available for multiple choices).





**Figure 6** | Questionnaire survey results.

From the results of the questionnaire survey in Figure 6, it can be seen that 1,094 tourists have chosen the quality of tourism resources as the main factor affecting their own tourism consumption, which indicates that people in modern society have higher requirements for the quality of tourism. 974 people have shown an understanding of whether rural areas are the concept of ecotourism and sustainable development or not, including tourists and residents. Only 537 tourists were satisfied with the ecological protection of tourism development. 1,111 tourists expressed preference for rural ecotourism. Another 896 people expressed their willingness to support the development of rural ecotourism, indicating that most tourists held a positive attitude toward rural ecotourism. However, 1,173 people expressed unrational views on whether the WR utilization is rational or not, which reached the largest number of all survey questions, indicating that the allocation of WRs has become a very serious problem. Another 1,142 people believed that the rational utilization of WRs could promote the sustainable development of rural ecotourism. Through the questionnaire survey, it can be reflected that the rational utilization of WRs played a certain role in promoting the sustainable development of rural ecotourism, while the existing rural ecotourism did not well allocate WRs. Therefore, this paper provided some strategies for the rational utilization of WRs in view of this problem.

### 5.3. Strategies for rational utilization of WRs to promote sustainable development of rural ecotourism

In order to achieve a positive interaction between rural ecotourism and sustainable development of WRs, ensure the sustainable development of rural tourism, ensure the rational utilization and sustainable utilization of WRs, and promote the sustainable development of rural ecotourism, WR rational utilization strategies include the following aspects:

#### 5.3.1. Definition of the concept of sustainable development and establishment of the awareness of rational utilization of WRs

It is necessary to recognize that WR is a non-renewable resource with certain scarcity, which is determined by itself, not by human will. Therefore, when developing rural ecotourism resources, it is necessary to plan development projects reasonably and combine the protection of local environment with the development of tourism industry so as to meet the needs of the present generation without endangering the ability of future generations to meet their needs.

#### 5.3.2. Setting up the concept of ecotourism with WRs as the core

During the development of rural ecotourism in China, insufficient understanding of natural resources often results in damage to the ecological environment, thus affecting the sustainable development of rural ecotourism in China. Therefore, education on environmental protection and sustainable development must be strengthened, and the concept of ecotourism centered on WRs must be established in the development of rural ecotourism so as to improve people's understanding of WRs and ecotourism. In the process of development, it is suggested to raise people's environmental and ecological awareness, make local residents fully realize the importance of resource protection and make them realize that ecological environment is the basis of human survival and development.

To ensure the sustainable development of rural ecotourism, it is necessary to strengthen environmental protection and sustainable development education to raise people's awareness of natural resources and ecotourism. In addition, it is recommended to enhance the environmental and ecological awareness of local residents, so that they recognize the importance of resource protection and that the ecological environment is the foundation of human survival and development. In short, when developing rural ecotourism, it is necessary to establish the concept of ecotourism centered on natural resources to ensure sustainable development.

### **5.3.3. Rational utilization of WRs and development of rural ecotourism**

Rural ecotourism is based on rural landscape and agricultural resources as tourist attractions, rural leisure and agricultural experience as main contents, protection of local ecological environment and cultural features as premise and development of rural tourism products with local characteristics as means. The rational utilization of WRs to develop rural ecotourism can make full utilization of local WRs and increase the income of local farmers. In the process of developing rural ecotourism, the sustainable development of WRs should be fully considered and the principle of water conservation and rational utilization should be adhered to. In the development and utilization of WR, a sound supervision and management system should be established and strengthened to manage and supervise WR. At the same time, a scientific, standardized, and effective WR management system and planning system should be established to ensure the rational and effective utilization of local WR. Rational arrangement of garbage collection and disposal in the scenic area are ensuring clean and hygienic environment. In addition, it is advisable to strengthen the cultivation of local residents' environmental awareness and enhance their environmental awareness.

### **5.3.4. Developmental adaption of rural ecotourism to local conditions**

In the development of rural ecotourism, the local natural environment, geographical location, and natural resource conditions should be fully considered, and the development should be rational according to local conditions. For example, in areas with abundant WR, activities such as water drifting and recreation should be carried out. In some areas with abundant wildlife resources, wildlife viewing, and field hunting activities should be carried out. In some areas with abundant agricultural resources, activities such as farm catering and farm experience should be carried out. In a word, rural ecotourism should be reasonably developed to meet the needs of tourists in accordance with local actual conditions and resource conditions. In addition, it should be made clear that rural ecotourism is a new form of tourism. With the increase of people's awareness of ecological environment protection, people's demand for rural ecotourism has also gradually increased. Therefore, the needs of local residents should be fully considered when developing rural ecotourism.

### **5.3.5. Reinforcement of the protection of WRs**

First, in the process of tourism development, it is suggested to adhere to the principle of 'less chopping, more planting' and take some measures to reduce the damage to vegetation. Secondly, some enterprises and activities that pollute WRs should be stopped in time and some behaviors that seriously pollute the environment should be investigated. Finally, attention is paid to the publicity and education of WR protection. It is necessary to raise people's awareness of water protection through various publicity activities and public service advertisements.

### **5.3.6. Rational development of WRs and enhancement of sewage treatment**

The development of rural ecotourism is inseparable from WRs. At present, there are many places in China, especially in the northern part, where WRs are seriously short and sewage in many cities is not treated well and discharged directly into rivers. This situation will have a negative impact on the development of rural ecotourism. The following are possible impacts: Ecological environment damage: Direct discharge of sewage into rivers can cause water pollution, thereby damaging the surrounding ecosystem, including aquatic organisms and vegetation. This will make tourists unable to enjoy the original beautiful natural landscape, reducing the attractiveness of rural ecotourism. Health risk: Polluted water sources may contain harmful substances and bacteria, posing a threat to human health. This will cause tourists to worry about their health and safety and may choose not to travel to such places anymore, further reducing the participation of rural ecotourism. Balance of nature destruction: shortage of WRs will destroy the balance of nature. If natural resources are not properly protected and managed, plant and animal populations in ecosystems will be threatened and may even become extinct. This will cause rural areas to lose their unique natural landscape and ecological resources, thus reducing their ability to attract tourists. In order to solve this problem, WRs should be reasonably developed first. The government should increase investment in sewage

treatment in rural areas and strengthen the treatment of rural sewage. In addition, scientific and effective measures should be taken to strengthen the treatment and management of rural sewage. The government should increase investment in rural sewage treatment facilities to ensure that local residents and tourists can enjoy a clean, healthy, hygienic and convenient living environment.

## 6. CONCLUSIONS

Rural ecotourism plays an increasingly important role in Chinese tourism industry. At present, with the continuous acceleration of national economic construction, tourism industry can usher in a period of rapid development. In this situation, effective measures must be taken to promote the sustainable development of rural ecotourism in China. As an important part of rural ecotourism, WR is also an important issue in the sustainable development of rural ecotourism in China. In this paper, starting from the general situation of rural ecotourism in China, the existing problems in the utilization of WRs were analyzed, and the relationship among the utilization of WRs, rural ecotourism and sustainable development was described. Through the rural ecotourism based on the rational utilization of WRs, the significance of rational utilization of WRs to the sustainable development of rural ecotourism was explored. According to the problems existing in the current utilization of WRs, some countermeasures were elaborated, hoping to contribute to the sustainable development of rural ecotourism. The biggest research achievement of this paper is to explore the relationship between the rational utilization of WRs and the realization of sustainable development of rural ecotourism, and to provide countermeasures for the rational utilization of WRs. However, while achieving certain results, there are also some problems in this paper.

However, while this paper has achieved some results, there are also some problems. Firstly, the experiment in this paper had many problems to be improved due to site limitation. Secondly, in terms of experimental data collection, only three cases of tourism villages were selected as data samples in this paper, without considering the situation of other villages. The experimental capacity was small and lack of data support. Moreover, the research results of this paper are established with the support of a large number of data, which is the expansion and deepening of the previous research results. It has certain reference value for the rational utilization of WRs, but it lacks innovation. Finally, sustainable development has always been a common concern of human beings. Rational utilization of WRs is related to all aspects of its allocation. It is self-evident that WRs are of great importance to human beings. In order to make rational utilization of WRs, it is needful to carry out continuous research and summary, and more importantly, all human beings need to create a social environment that cares for WRs. In order to further understand the impact of rational utilization of WRs on the sustainable development of rural ecotourism, the analysis results can be further improved in the follow-up study according to these problems.

## FUNDING

This research was funded by: Anhui Provincial Department of Education Excellent Young Talents Project: Research on the Influence Mechanism of Rural Tourists' Behavior in the Context of Epidemic Normalization (gxyq2022037); 2022 Project of 'School-Enterprise Cooperation Practice Education Base' of Undergraduate Teaching Project of Fuyang Normal University (2022XQSJJD01); Fuyang Normal University-Fuyang City 2022 City-University Cooperation Science and Technology Special Project 'Research on Cultural and Tourism Science and Technology Product Development Based on the Mechanism of Song Rhythm Cultural Evolution' (SXHZ202209).

## DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

## CONFLICT OF INTEREST

The authors declare there is no conflict.

## REFERENCES

- Abbasi, S., Mirdamadi, S. M., Najafabadi, M. O. & Hoseini, S. J. F. 2022 Designing a model of rural ecotourism entrepreneurship development with a qualitative approach. *Geography and Development* **20** (66), 131–160.
- Adu, D. T. 2018 Application of livelihood vulnerability index in assessing smallholder maize farming households' vulnerability to climate change in Brong-Ahafo region of Ghana. *Kasetsart Journal of Social Sciences* **39** (1), 22–32.

- Chin, C.-H., Chin, C.-L. & Wong, W. P.-M. 2018 The implementation of green marketing tools in rural tourism: the readiness of tourists? *Journal of Hospitality Marketing & Management* **27** (3), 261–280.
- Creevey, D., Kidney, E. & Mehta, G. 2019 From dreaming to believing: a review of consumer engagement behaviours with brands' social media content across the holiday travel process. *Journal of Travel & Tourism Marketing* **36** (6), 679–691.
- Khalili, S., Moridsadat, P. & Soltaninejad, H. 2020 Toward sustainable rural ecotourism evolution: the case of Kiskan, Iran. *Geography, Environment, Sustainability* **13** (3), 39–48.
- Liang, Y. & Shi, C. 2020 Efficiency evaluation and optimization of rural ecotourism space based on DEA model. *International Journal of Low-Carbon Technologies* **15** (3), 356–360.
- Marques, C. P., Guedes, A. & Bento, R. 2022 Rural tourism recovery between two COVID-19 waves: the case of Portugal. *Current Issues in Tourism* **25** (6), 857–863.
- Nugroho, I., Hanae, R., Negara, P. D. & Yuniar, S. a. H. R. 2021 Social capital and social capacity in rural ecotourism development. *The Indonesian Journal of Geography* **53** (1), 153–164.
- Pencarelli, T. 2020 The digital revolution in the travel and tourism industry. *Information Technology & Tourism* **22** (3), 455–476.
- Ramon-Hidalgo, A.-E. & Harris, L. M. 2018 Social capital, political empowerment and social difference: a mixed-methods study of an ecotourism project in the rural Volta region of Ghana. *Journal of Sustainable Tourism* **26** (12), 2153–2172.
- Sarkar, S. K. & George, B. 2018 Social media technologies in the tourism industry: an analysis with special reference to their role in sustainable tourism development. *International Journal of Tourism Sciences* **18** (4), 269–278.
- Schweinsberg, S., Darcy, S. & Wearing, S. L. 2018 Repertory grids and the measurement of levels of community support for rural ecotourism development. *Journal of Ecotourism* **17** (3), 239–251.
- Sepahvand, R., Jafari, M., Sepahvand, L. & Ahmadi, A. 2018 Strategic planning for development of rural ecotourism (Case study: bisheh station village). *Human Geography Research* **50** (2), 263–276.
- Sheffield, J. 2018 Satellite remote sensing for water resources management: potential for supporting sustainable development in data-poor regions. *Water Resources Research* **54** (12), 9724–9758.
- Sofronov, B. 2018 The development of the travel and tourism industry in the world. *Annals of Spiru Haret University Economic Series* **18** (4), 123–137.
- Xu, X. & Pratt, S. 2018 Social media influencers as endorsers to promote travel destinations: an application of self-congruence theory to the Chinese Generation Y. *Journal of Travel & Tourism Marketing* **35** (7), 958–972.

First received 9 May 2023; accepted in revised form 22 August 2023. Available online 31 August 2023