



Studies on the eco-safety prewarning system construction and sustainable development of Yuntai Mountain in Jiaozuo city

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ABSTRACT

Yuntai Mountain is Chinese famous tourist spot. The study on the ecological security of Yantai Mountain has more practical significance. This paper studies on the Yuntai Mountain and the author constructs an ecological safety (eco-safety) evaluation index system characterized by Yuntai Mountain scenic eco-environment system and constructs the Yuntai Mountain index system on the basis of P-S-R model. From the overall evaluation results, the eco-safety is relatively high in Yuntai Mountain area according to the eco-safety value 0.8577, which is between 0.75 and 1 safe state value. Lastly the paper proposes strategies to optimize the eco-environmental safety by analysing and evaluating the index system based on the current situation and features of Yuntai Mountain scenic area.

Keywords: Yuntai Mountain, eco-safety, prewarning system, sustainable development

INTRODUCTION

Yuntai Mountain Scenic Area is graded as a National 5-A Scenic Spot in China and also regarded as a World Geopark. Yuntai Mountain, as the southern part of Taihang Mountains, is located in Xiuwu County, 30 kilometres northeast of Jiaozuo City, Henan Province. It has the distinctive "Northern Karst" with the major scenery of canyon streams and geological landscapes, thus being listed as one the first world geological parks. Meanwhile, Yuntai Mountain Scenic Area has been awarded with 6 national-level titles, including National 5-A Scenic Spot, National Key Scenic Spot, National Forrest Park, National Geological Park, National Water Conservancy Scenic Spot and National Macaques Nature Reserve, and this is the only one case in Henan Province. Yuntai Mountain area covers 190 square kilometres, stepwise-shaped from north to south, with the highest altitude of 1359 meters above sea level and the lowest of 90 meters. The landform here is complex for the stagger peaks and valleys, which enables the formation of Yuntai Fall, the highest waterfall in Asia. In recent years, tourism resources, including the infrastructure and public services, are increasingly invested in Yuntai Mountain area, which expands the scale of tourism industry, thus creating remarkable economic and social benefits.

According to statistics, in 2010 Yuntai Mountain Scenic Area welcomed 3,920,000 tourists and earned 300 million Yuan for ticket sales, increasing by 19.6-fold and 75-fold respectively compared to those of 2000. The rapid development of tourism greatly stimulated the GDP growth and also the tertiary industry was quickly improved. With the impressive achievement achieved, we should also be aware that this mountain-type scenic area has a high degree of environmental sensitivity and vulnerability. It can be easily damaged in a large scale due to improper exploiting. At present, the rapid development of Yuntai Mountain Scenic Area not only provides a large number of local employment opportunities, but also greatly boosts the local economy. Since tourism is a double-edged sword, Yuntai scenic area brings positive effects to the society, however, it is also likely to interfere the good local natural resources and threaten the local environmental quality and biodiversity.

This paper constructs a safety evaluation index system for Yuntai Mountain Scenic Area, and assigns correlative indicators to determine the regional eco-safety evaluation index thresholds, calculates Yuntai Mountain's safety evaluation results, and finally proposes relevant recommendations and strategies based on the results.

1. The Construction of Yuntai Mountain Safety Evaluation Index System

Evaluated by 3 index groups, namely, tourism eco-environmental pressures, tourism eco-environmental quality and tourism eco-environmental impacts, the Yuntai Mountain index system is constructed on the basis of P-S-R model adopting both domestic and foreign methods on eco-safety evaluation as the following Table 1:

Table 1. Yuntai Mountain Safety Evaluation Index System

Yuntai Mountain Safety Evaluation Index System O	Eco-environmental pressures A1	Population pressure B1	Growth rate of tourists C1
			Growth rate of tourism practitioners C2
			Growth rate of local population C3
		Land resources pressure B2	Increasing rate of tourism land demand C4
			Increasing rate of ecological land C5
		Water environment pressure B3	Water pollution pressure C6
		Pollutant Load B4	Tourism pollution load C7
		Tourism resources pressure B5	Tourism capacity C8
			Intensity of use of tourism land C9
			Water quality C10
	Eco-environmental quality A2	Tourism environmental quality B6	Air quality C11
			Environmental noise C12
			Solid waste disposal rates C13
			Forest coverage rate C14
		Tourism ecological environment B7	Biological diversity C15
			Ecological function quality C16
	Eco-environmental response A3	Investment capability B8	Per Capita GDP C17
			Ecological construction input intensity C18
		Science and technology capability B9	Quality of tourists C19
			Quality of tourism practitioners C20
			Quality of local residents C21
		Waste processing capability B10	Effectiveness of pollutant disposal C22

2. The Confirmation of Index Weight in Yuntai Mountain Safety Evaluation System

Confirming the safety evaluation index weight is the key point in this paper. Based on the previous scholars' research findings of other similar tourism areas, relevant experts from History and Culture Institute of Henan University and Jiaozuo Tourist Administration held a discussion to assign and amend each index weight considering the practical situation of the tourism development in Jiaozuo. The final results are shown in Table 2.

3. The Election of Index Threshold in Yuntai Mountain Safety Evaluation System

Eco-safety refers to the health and integrity of the ecosystem. Its degree is determined by the supporting capacity of the regional ecosystem services. In the tourism environment indexes, each one has a limited range. When the limit is exceeded, the unsafety of ecosystem may appear. This range of value is commonly called the threshold of ecosystem [1]. In this sense, the regional eco-safety evaluation criteria can be comprehended as regional eco-safety threshold. Considering the current imperfect construction of Chinese tourism environmental standard system, the author will adopt other eco-functional areas' evaluation standards which are resulted from the following aspects: 1. The mandatory standards stipulated by the state, the tourism industry and the local government. For example, the safety evaluation on water and air mainly complies with the national environmental standards on surface water and air quality, combined with the grading and evaluation standards (ISO14000) on the quality of tourist areas as well as the evaluation standards for national demonstration zones; 2. Analogue standards. Standards can be set by referring to the similar eco-environment interfered by human activities and also the tourism development with the equivalent strength of the similar tourism areas; 3. International and domestic recognition value. This mainly passes international or domestic long-term test, and is recognized by the academia; 4. The value of expertise. In the absence of reliable standard references, the study experiences and results of experts can be taken as the standards.

4. The Calculation on Safety Index of Yuntai Mountain Eco-safety Evaluation Index

Set $X_i (i = 1, 2, 3, \dots, 22)$ as the index value of the i th indicator; $P(C_i)$ as the safety index of the i th indicator, $0 \leq P(C_i) \leq 1$; XS_i as the threshold of the evaluation index. Safety threshold is generally divided into two categories: the first is a positively related index with eco-safety, that is, the greater and the safer index determines the safety threshold lower limit. At this point, if $X_i \geq XS_i$, then $P(C_i) = 1$; If $X_i < XS_i$,

then $P(C_i) = \frac{X_i}{XS_i}$. The second is a negatively related index with eco-safety, namely, the smaller and the index determines the safety threshold upper limit. At this point, if $X_i \leq XS_i$, then $P(C_i) = 1$; If $X_i > XS_i$, then $P(C_i) = \frac{XS_i}{X_i}$ [2].

Table 2. The Index Weight and Threshold of Yuntai Mountain Eco-safety Evaluation Index System

Index and Code	Index weight	Index threshold	Data source
C1 Growth rate of tourists %	0.0808	13.1%	The 2010 average data of Henan Province
C2 Growth rate of tourism practitioners %	0.0374	22%	The 2010 average data of Henan Province
C3 Growth rate of local population ‰	0.0233	6.3‰	The 2010 average data of Henan Province
C4 Increasing rate of tourism land demand %	0.0187	5%	Expertise
C5 Increasing rate of ecological land %	0.0562	1.32%	Planning for tourism industry
C6 Water pollution pressure (Water self-purification capacity / discharge capacity)	0.075	1	Self-defined
C7 Tourism pollution load	0.093	62.34	The 2010 average data of Henan Province
C8 Tourism capacity % (the actual reception capacity / environmental capacity)	0.0419	90%	Expertise
C9 Intensity of use of tourism land (scenic spot construction area / visited area)	0.0419	2	Expertise
C10 Water quality	0.1243	A Level	GB3095-1996
C11 Air quality	0.0633	A Level	GB3838-2002
C12 Environmental noise (dB)	0.0252	<50	National standard
C13 Solid waste disposal rates %	0.0902	100	National standard
C14 Forest coverage rate %	0.0923	70	The implementation of forestry law
C15 Biological diversity	0.0188	Excellent	Compared with the similar scenic spot
C16 Ecological function quality	0.0461	Good	Compared with the similar scenic spot
C17 GDP Per Capita	0.0117	29970	The 2010 average data of the whole nation
C18 Ecological construction input intensity (Ecological construction input / GDP)	0.0598	1.5	The 2010 average data of the whole nation
C19 Quality of tourists % (population of College degree or above / total population)	0.0216	30%	The 2010 average data of the whole nation
C20 Quality of tourism practitioners % (population of College degree or above / total population)	0.0385	80%	Quality of tour-guide service
C21 Quality of local residents % (population of Junior high school degree or above / total population)	0.0039	57.55%	The 2010 average data of Henan Province
C22 Effectiveness of pollutant disposal %	0.0076	70	ISO14000

Note: representing by excellent, good, medium, poor, very poor, namely, the assignment of the safety value 1, 0.75, 0.5, 0.25, 0

5. The Calculation on the Degree of Yuntai Mountain Eco-safety

Comprehensive evaluation on the eco-safety of Yuntai Mountain by linear weighting method:

$$P(O) = \sum_{i=1}^{22} W(C_i) \times P(C_i) \quad (1)$$

Where $P(O)$ is the eco-safety degree of Yuntai Mountain, $W(C_i)$ is the weight of the i th indicator, and $P(C_i)$ is the safety index of the i th indicator [2].

The eco-safety of the scenic spot is divided into 4 levels, see Table 3

Table 3. The Grading of Eco-safety Evaluation of the Scenic Spot

Grade	unsafety	comparative unsafety	comparative safety	safety
Standard	$0 \leq P < 0.25$	$0.25 \leq P < 0.5$	$0.5 \leq P < 0.75$	$0.75 \leq P < 1$

6. Evaluation Results of Yuntai Mountain Eco-safety

See Table 4.

From the overall evaluation results, the eco-safety is relatively high in Yuntai Mountain area according to the eco-safety value 0.8577, which is between 0.75 and 1 safe state value. However, there are still potential eco-safety problems. If we don't take measures in time, the existing eco-safety state might be destroyed. Specifically, the

contribution value of the eco-environmental response (A3) is only 0.0915, which indicates that the improvement and investment in eco-environment is inadequate. The stability and anti-risk capability of Yuntai Mountain scenic area is weak, so the eco-safety is likely to be threatened once it faces with unexpected ecological risk or a sudden surge in tourist arrivals in a short period [3].

Table 4. Evaluation Results of Yuntai Mountain Eco-safety

Index code		$P(C_i)$	$W(C_i) \times P(C_i)$	P		
A1	B1	C1	0.6742	0.054475	0.1040	0.3618
		C2	0.7333	0.027425		
		C3	0.9523	0.022189		
	B2	C4	0.625	0.011688	0.0487	
		C5	0.66	0.037092		
	B3	C6	1	0.075	0.075	
	B4	C7	0.9537	0.088694	0.0886	
	B5	C8	0.4864	0.02038	0.0455	
		C9	0.6006	0.025165		
A2	B6	C10	1	0.1243	0.2793	0.4044
		C11	1	0.0633		
		C12	1	0.0252		
	B7	C13	0.738	0.066568	0.1251	
		C14	0.7777	0.071782		
		C15	1	0.0188		
A3	B8	C16	0.75	0.034575	0.0507	0.0915
		C17	0.0789	0.000923		
	B9	C18	0.8333	0.049831	0.0346	
		C19	0.7894	0.017051		
		C20	0.375	0.014438		
	B10	C21	0.8004	0.003122	0.0062	
		C22	0.8235	0.006259		
Total					0.8577	

7. The Current Eco-safety Status and the Potential Eco-safety Risks of Yuntai Mountain Scenic Area

From Table 4, it can be concluded that $P(A_2) > P(A_1) > P(A_3)$, and this indicates that:

7.1 High Eco-environmental Pressure in Yuntai Mountain Area

From Table 2, in the eco-safety evaluation index system, only 2 items of eco-environmental pressures A1 reach the standard, namely, the rate of local population C3 and water pollution pressure C6, and the rest ones all exceed the index threshold, among which are growth rate of tourists, growth rate of tourism practitioners, increasing rate of tourism land demand, increasing rate of ecological land, tourism pollution load, tourism capacity, intensity of use of tourism land, etc. So we can see Yuntai Mountain area bears a high pressure on eco-environmental safety [4].

7.2 High Tourist Flow Volume and High Pressure of Tourism Resources in Yuntai Mountain Area

In Table 2 we can see that the threshold of tourist growth rate is 13.1% while the tourist growth rate index value is 19.43%, which is apparently higher than the threshold. The severest item is C8 tourism capacity whose threshold is 90% while the tourism capacity of Yuntai Mountain area reaches 185%, exceeding the threshold more than doubled. It can be noticed that the tourist flow volume in Yuntai Mountain area far exceeds the standard, and this is the greatest hazard to the eco-safety of the scenic area.

In the meantime, the quality of tourism practitioners needs to be improved. From Table 2, we can see that with the increasing number of visitors, the number of tourism practitioners is also significantly rising with the growth rate of 30% in 2010, which is much lower than the threshold standard 80%. Therefore, the quality of tourism practitioners requires improvement in order to meet the growing needs of tourists [5].

7.3 Good Ecological Environment Quality in Yuntai Mountain Area

We can see from Table 2, in the index assessment of the scenic eco-environmental quality, most of the index values are up to the standard, i.e., the index value of the forest coverage rate reaches 90%, exceeding the threshold of 70%; the biological diversity achieves excellent level, and ecological function quality also achieves higher level than the index threshold. Based on this, we can say that the eco-environmental quality of Yuntai Mountain scenic area is overall good. This is mainly due to the increasing input in environmental protection and the improving quality of the staff in the scenic area. In addition, it also illustrates that the eco-safety situation has been greatly improved under the conditions allowed [6]. Currently there are still problems, such as the imperfect facilities for environmental resources protection, the low level of harmless treatment for contaminants, the backward technology of testing

equipment of natural resources and the cluttered environment along the main roads.

8. The Sustainable Development Strategies for Yuntai Mountain Scenic Area

In 1995, the International Conference on Tourism was held in the Canary Islands, Spain, and two documents "Charter for Sustainable Tourism Development" and "Sustainable Tourism Development Action Plan" were approved by the World Tourism Organization [7]. Based on the ideas of the two documents above and taking the scenic area's current characteristics into consideration, this paper raises some suggestions on the sustainable development from the following aspects:

9.1 Formulating Scientifically and Planning the Scenic Capacity Rationally

In the 1995 International Conference on Tourism, the documents adopted by the World Tourism Organization highlighted the issue of tourism capacity, that is, the eco-tourism environmental endurance people used to say. The healthy development of tourism must depend on the local eco-environment testing, take the environmental endurance into account and comply with the local economic situation and social ethics. This is the key point for performing and carrying out the tourism sustainable development, and also the major guideline for managing the tourism resources. As a natural landscape area, Yuntai Mountain Scenic Area has a limited capability of tourists. According to the survey and analysis, it can be noticed that this area has a high scenic population pressure with the rapid development of local tourism, i.e., the increasing number of tourists as well as the tourism practitioners, resulting in the higher tourism capacity than the index threshold. In this case, the tourist spatial capacity is required attentions, therefore, the Yuntai Mountain scenic area need to continuously improve the traditional calculation methods and learn more mature capacity calculation methods both at home and abroad in order to scientifically determine the exact value of scenic tourist capacity. In addition, during the peak season, it is necessary to strengthen the cooperation between management and other departments, make adjustments to the reception policies based on the scientific data. In this way can the scenic burden be alleviated and the tourist experiences of high quality be achieved simultaneously.

9.2 Planning Reasonably and Making Applicable Distribution in the Scenic Area

It is a wise choice to organize experts or scholars to study on the distribution of the attractions and the tour itineraries and make adjustments in order to achieve an optimal layout, in which the negative impacts on the eco-environment are minimized, the utilization of tourism resources is maximized and the tourist congestion is largely alleviated. Particularly, in peak tourist seasons, some of the popular attractions needs to adopt special entry policies, such as the time limit and quantity limit on the tourists, in order to avoid the overcrowded situation in popular attractions or the deserted phenomenon in ordinary attractions.

9.3 Controlling the Intensity of Tourism Activities and Reducing the Impacts on Environmentally Sensitive Areas

The more beautiful the scenery is, the more tourists visit, the higher sensitivity the area has, and the more vulnerable the area to be destroyed. The Yuntai Mountain area is confronted with many problems, such as the low use ratio of the sceneries and the high concentration degree of tourist scope, so it is necessary to strengthen the environmental carrying capacity, and measures can be taken by managing the tourist flow rate by effective management or price adjustment. Particularly in peak tourism season, the scientific planning is urgently required for appropriate arrangement in different attractions, tourist flow restrictions in environmentally sensitive areas or reasonable distribution of tourists in order to reduce the pressure on natural resources, decrease the interference in eco-environment and prevent the destruction of natural resources. Besides, the drainage facilities in the scenic area are needed to be arranged and the exposed soil to be re-covered to prevent the soil erosion and geological disasters.

9.4 Improving Environmental Governance and Enhancing the Eco-environment Quality

From the analysis in the previous section, we can see the eco-environment is in an overall good condition, and this might be the main reason why Yuntai Mountain can continuously attract visitors. However, there are also disharmonious factors that affect the eco-environment of this scenic area. From the statistics, the threshold of tourist pollution load is 62.34 while the index value of this area is 65.36 exceeding the scope of index threshold, which indicates that the tourism pollution load is out of the limit. Meanwhile, the solid waste disposal rate is low with only 73.8% which does not reach 100%. Apparently, the solid waste disposal rate does not match the standard. Therefore, Yuntai Mountain area should keep improving the environmental governance, thus enhancing the eco-environment quality.

Firstly, the environmental education and resources conservation need to be emphasized and the investment into scenic environmental protection needs to be increased. Special funds on environmental protection can be set up to offer financial support for the environmental education, environmental protection and eco-environmental construction. At the same time, the scenic green project construction must be accelerated in order to reduce the soil

erosion. What is more, the advanced pollutant disposal equipment should be supplied to do the environmentally harmless treatment on the pollutants. For example, the buried unpowered sewage treatment devices can be used to manage the whole scenic waste water disposal and meet the requirements of sewage discharge in the scenic area. Bio-safety disposal facilities can also be used to reduce the damage and the pollution of the waste to the environment [8].

Secondly, the tourism operators should take the lead to protect the environment. They can adopt the idea of “Green Management” to reduce pollutant emissions and reduce the share of natural resources. In spite of this, they should educate consumers with the concept of “Green Consumption” to enhance the environmental awareness of tourists, strengthen the idea of eco-environment thus solving the problem of environmental pollution essentially.

At last, the tourism industry should reconstruct the energy structure. Specifically, try to use electricity as the power instead of high-polluting fuels to reduce the air pollution.

9.5 Paying Attention to Tourguide Management & Training and Leading Tourism Scientifically

Currently in Yuntai Mountain scenic area, the number of tourism practitioners is surging, but the quality of the staff is not. According to the 2010 data, the tourism practitioners with college degree or above only takes up to 30%, which is far lower than the index threshold of 80%. In order to improve the quality of tourism practitioners, we must continue to strengthen their quality education of ecological ethics, which requires the training mechanism of the internal management being strengthened, thus offering the systematic and sufficient learning. Except from the learning and training, we also need to make fair and reasonable rules and regulations to ensure the improvement of tourism practitioners' quality. Only with the high quality of tourism practitioners can they positively supervise the tourists, guide the visitors to protect the eco-environment, thus achieving the sustainable development of the scenic area.

9.6 Establishing Digitalized Eco-safety Monitoring System

To realize the digitalization of operation and management, we need to use the modern information technology to do the real-time monitoring on the eco-environmental changes, use the advanced eco-management information system to assess, analyse and process the eco-environment information. With the monitoring system, we can also apply the visual monitoring on the dynamic changes of geology, hydrology and air conditions to manage the disaster information of the scenic area, so that we can timely and rapidly give the prewarning on the scenic area's insecurity. Also, we can take a central database comparison to evaluate the environmental carrying capacity and geological eco-environmental status. With the evaluation, we can make a proper analysis on the revenue risk of the tourism project in the scenic area, which will provide a scientific basis for latter ecological protection and restoration.

9.7 Strengthening Regional Tourism Cooperation and Achieving Win-win Situation within the Scenic Area

New trends in world tourism development requires that we need to create an environment for the ecological security of regional tourism cooperation, by which not only can we achieve the interaction among the tourism markets and complementation in the tourism resources, but also can promote the eco-environmental protection and sustainable development within the area. Yuntai Mountain's location is in both Xiuwu County, Jiaozuo City, Henan Province and Lingchuan County, Jincheng City, Shanxi Province, so the jurisdiction of this scenic area has become a contention point of the two regions. They separately carry out large-scale construction on Yuntai Mountain area for tourism development, blasting rocks, artificially blocking the river and constructing the basic infrastructure. All these activities result in the constant increase in the possibility of geological disasters that threaten the security in the scenic area. For example, the famous Yuntai Waterfall has become a seasonal waterfall, which means that we can see its magnificence only in the rainy season. Also, the running water in Laotangou Scenic Spot is reducing, and only the water at the bottom can be seen. Therefore, we must improve and establish inter-regional tourism cooperation mechanism, abandoning local protection, to develop, protect and share the benefit jointly. We also positively seek measures to solve problems to achieve the sustainable development of eco-environment in Yuntai Mountain Scenic Area as soon as possible [9].

CONCLUSIONS AND DISCUSSION

This paper studies on the Yuntai Mountain Scenic Area, structuring an evaluation index system of eco-environment characterized by the mountain scenic area. By analysing and evaluating the index system combined with the current situation and features, the author proposes some strategies to optimize the eco-environmental safety, aiming at objectively reflect the current ecological status. Through the analysis on the influential factors, we can have a macroscopic understanding of the sustainable development ideas and its standards, thus we are able to raise rational suggestions and strategies for the sustainable development in the scenic area.

In short, to achieve sustainable development of tourist attractions, the managers need to carry out an appropriate plan on the basis of marketing and decide a reasonable plan on scenic capacity to ensure efficient operation of the scenic area with a long-term and global thinking for development. In addition, an environmental management system needs to be established by adopting the advanced ideas to ensure the sustainable development. Meanwhile, we also need to strengthen the training for tourism practitioners to improve their self-quality, build up an advanced digitalized monitoring system to improve the scenic area's ability of monitoring the eco-safety, and also strengthen the inter-regional cooperation. All the measures listed above will positively support the sustainable development in Yuntai Mountain area.

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