

ENVIRONMENTAL IMPACT OF TOURISM ACTIVITIES ON ECOLOGICAL NATURE RESERVES

HAN, F. L.^{1*} – LI, C. T.²

¹*Suihua University, Heilongjiang 152061, China*

²*Harbin Normal University, Heilongjiang 150025, China*

**Corresponding author
e-mail: h200168106@163.com*

(Received 3rd Apr 2019; accepted 17th May 2019)

Abstract. With the rapid development of tourism, tourism activities have a certain impact on the environment of ecological nature reserves. Taking Wuyishan National Nature Reserve as the research object, this paper explores the impact of tourism activities on the environmental carrying capacity, vegetation landscape and atmospheric environment of natural ecological protection areas, and seeks measures for the coordinated development of tourism activities and ecological natural protection. The results show that the results of different tourism carrying capacity components vary greatly, and the number of tourists in Wuyishan National Nature Reserve has exceeded the value of tourism environmental carrying capacity. The influence of tourism activities on vegetation landscape is great and 6 out of the 20 samples tested are moderate interference. The closer the samples are to the travel path, the greater the interference degree on vegetation landscape is, the greater the interference by tourism activities is, and the smaller the ecological benefit value of the sample is. This study provides a theoretical and experimental basis for the sustainable development of tourism activities and ecological nature reserves.

Keywords: *tourist activities, ecological nature reserve, environmental science, ecological benefits, sustainable development*

Introduction

With the development of economy and the change of people's thought, tourism is called the gold medal industry in the 21st century. Tourism activities have the functions of increasing knowledge, cultivating sentiment, raising quality, promoting civilization and strengthening physique. It is also a symbol of the ever-increasing economic and cultural life of people (Jurigová and Zuzana, 2016; Movono et al., 2018). However, tourism activities are carried out with the complex activities of human beings, and the consumption of resources caused by tourism activities is increasing, which brings a plenty of environmental pressure on the ecological environment, including soil pollution, solid waste discharge, noise pollution and predatory development of lands in reserves (Mirela and Butnaru, 2015). The ecological nature reserves are the areas divided by the State and the region in order to maintain species diversity. They are of great significance to maintain the ecological balance, protect the natural and historical heritage and promote the development of scientific research and tourism. We should be pay attention to the protection and restoration of diversity of animal and plant species in ecological nature reserves, as well as protection and development of regional characteristics and natural landscape (Popp, 2014; Giddy and Webb, 2015). The tourism activities in ecological nature reserves can drive local economic development, bring considerable economic benefits to the local area, and bring natural landscapes to tourists, but the construction of tourism infrastructure in nature reserves and the trampling of

tourists cause damage to the reserves (Hjalager and Johansen, 2013). In recent years, the ecological protection and restoration of eco-tourism areas are lagging behind due to the destruction of tourism activities. People gradually realize that tourism activities are a "double-edged sword", and eco-tourism has gradually developed into a favored way in the tourism market, with a focus on conservation of the natural environment and the natural landscape (Buswell and Buswell, 2011; Tikkanen et al., 2017). The national ecological nature reserves are the main carriers for tourism activities, with a limited capacity to withstand people's interference and destruction, and tourism activities will be destroyed to varying degrees and may cause species degradation in serious cases (Krupczek and Micha, 2016). Taking Wuyishan National Nature Reserve as the research object, this paper explores the impact of tourism activities on the environmental carrying capacity, vegetation landscape and atmospheric environment of natural ecological protection areas, and seeks measures for the coordinated development of tourism activities and ecological natural protection.

Materials and Methods

The environmental carrying capacity of national ecological nature reserves is an important index to limit the excessive tourism intensity, and represents the threshold for the capacity to support human socio-economic activities in certain period, under certain conditions and specific regional conditions (Nyahunzvi and Kennedy, 2015). The environmental carrying capacity not only refers to macroscopic natural environment, but also includes social environment, spiritual environment and management environment. It has objectivity, comprehensiveness, variability, feedback and finitude (Hayward and Kuwahara, 2013). Taking Wuyishan National Nature Reserve as an example, the indexes of its environmental carrying capacity includes resource space carrying capacity, ecological environment, economic environment and social environment carrying capacity (Ritter, 2009).

Table 1 shows the distribution of tourist sources in Wuyishan National Nature Reserve and the main domestic tourists come from Jiangxi, Fujian and Guangdong.

Table 1. Distribution of tourist sources in Wuyishan National Nature Reserve

Province	Passenger origin	Province	Passenger origin
Jiangxi	15.52%	Hunan	7.89%
Fujian	17.63%	Hubei	6.23%
Jiangsu	9.3%	Shandong	2.65%
Zhejiang	6.8%	Beijing	2.11%
Guangdong	13.65%	Sichuan	1.99%
Anhui	5.5%	Other	10.73%

Figure 1 shows the annual tourists in Wuyishan National Nature Reserve and the annual tourists increase year by year, up by 2.44 times from more than 6.4 million tourists in 2010 to more than 15.62 million in 2018. According to the official statistics of Wuyishan National Nature Reserve, the total number of tourists received exceeded 15 million for the first time in 2018, nearly 2.8 million more than in 2017, which is the biggest growth year.

This paper mainly analyses the carrying capacity of ecological environment and social economy, among which the carrying capacity of ecological environment includes the carrying capacity of atmospheric environment (gaseous pollutants and suspended particles), water environmental carrying capacity (chemical oxygen content and ammonia nitrogen content index), and socio-economic carrying capacity includes psychological and spatial capacity (Hanna et al., 2015). *Figure 2* is the environmental bearing capacity value of Wuyishan National Nature Reserve. It can be seen that the environmental bearing capacity value of each index is different greatly, and the ecological environment bearing capacity is the largest, which is calculated according to the current bearing capacity value. At present, the total amount of tourists received in Wuyi Mountain exceeds the carrying capacity of water resources and environment.

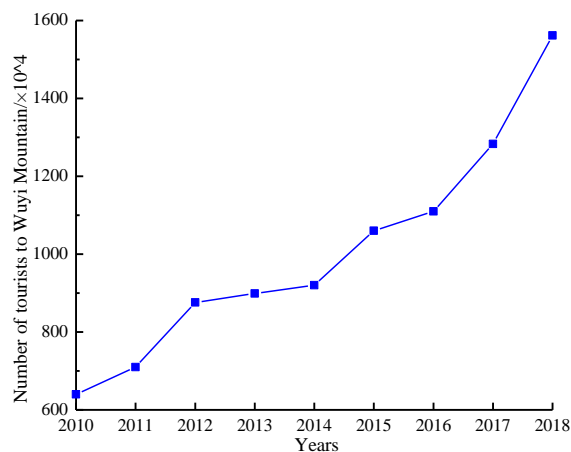


Figure 1. Annual reception volume of tourists in Wuyishan National Nature Reserve

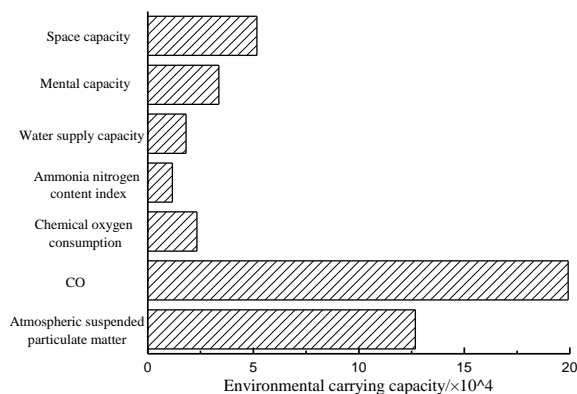


Figure 2. Environmental carrying capacity of Wuyishan Ecological Nature Reserve

Results

Ecological response of vegetation landscape to the interference of tourism activities

The vegetation landscape is the main component of Wuyishan National Nature Reserve, which is the most susceptible to the influence of tourism activities. The destruction of the vegetation landscape by tourism activities is divided into systematic destruction and local destruction. *Table 2* shows the purposes of visiting Wuyi

Mountain. According to the questionnaire, tourists come to Wuyi Mountain mainly to enjoy the scenery and relax and the diversity of vegetation species provides a rich experience to tourists. According to the investigation results, the trees in Wuyishan National Nature Reserve contain 14 families, 18 genera, and 24 species, 32 species in shrub layer, 41 species in herbaceous layer, while the vegetation is rich in species.

Table 2. Tourists visit Wuyishan for the purpose of travel

Tourism purpose	Enjoy the scenery	Exercise	Relax	Delicious snack	Other
Proportion/%	57.61%	9.23%	26.59%	3.13%	3.44%

Figure 3 shows a vegetation landscape ecological effect evaluation system, which includes four parts such as vegetation importance, species diversity, community structure ratio and plant dominance. Wuyi Mountain is divided in 20 10 m × 10 m sample squares, and the species, height, coverage and cluster of species in the samples are recorded. The evaluation index TD of Wuyi Mountain vegetation landscape is as follows:

$$TD = 1 - \frac{S/S_{max}+H/H_{max}+C/C_{max}+L/L_{max}}{4} + A \quad (\text{Eq.1})$$

where S, H, C and L represent the number of actual species, average height of species, vegetation coverage and vertical structure of vegetation in the samples, S_{max}, H_{max}, C_{max} and L_{max} represent the maximum value of the data measured in the samples, and A represents the ecological dominance value.

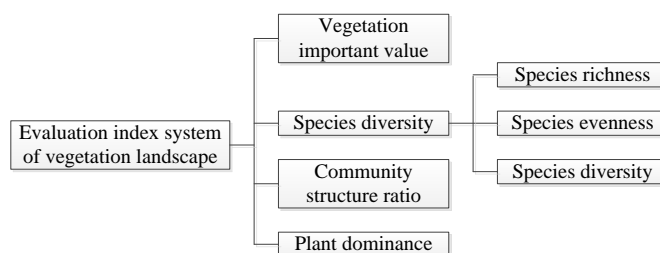


Figure 3. Vegetation landscape ecological effect evaluation system

Figure 4 shows the influence of tourism activities on the number of vegetation species and vegetation coverage, and the larger the number of vegetation species and vegetation coverage value are, the greater the species richness is.

Figure 5 shows the impact of tourism activities on the average height and vertical structure of vegetation. The higher the average height and the vertical structure of vegetation are, the more vegetation the tree layer has. Figure 6 shows the ecological benefit value of the vegetation landscape of Wuyi Mountain. The larger the interference by the tourism activity is, the smaller the ecological benefit value of the samples is, and the quality of the vegetation landscape is deteriorated due to the tourism activity. Table 3 is the calculation of the interference degree of the selected samples. It can be seen that the interference degree of samples 5-10 is severe, and that of other samples is mild.

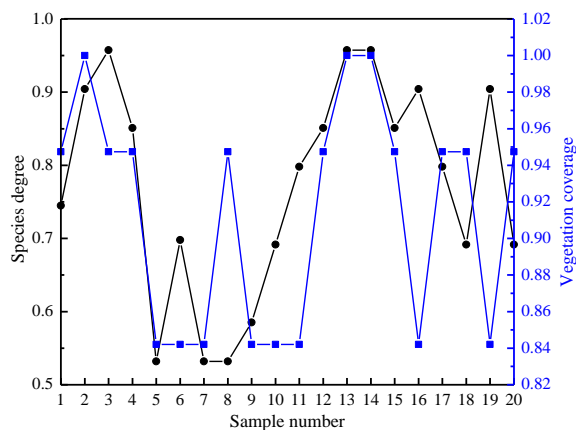


Figure 4. Effects of tourism activities on the number of vegetation species and vegetation coverage

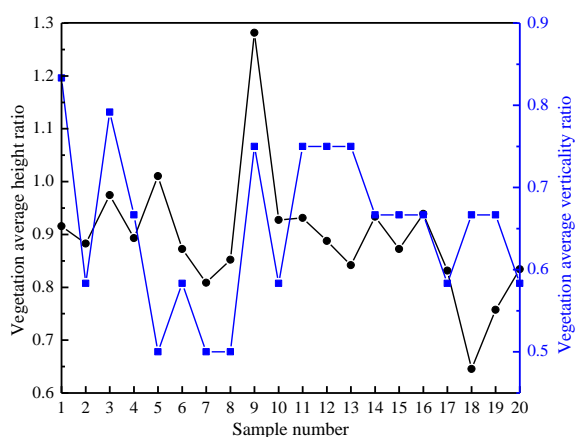


Figure 5. Effects of tourism activities on the average height of vegetation and the vertical structure of vegetation

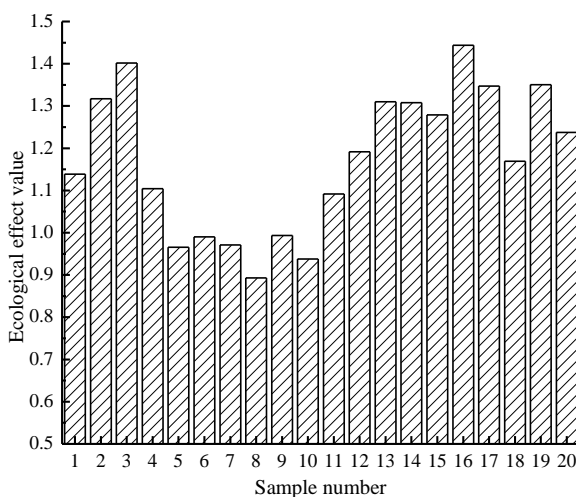


Figure 6. Ecological benefit value of vegetation landscape in Wuyi Mountain

Table 3. Calculation of the degree of interference of the selected sample

NO.	Interference degree	NO.	Interference degree	NO.	Interference degree
1	Mild interference	8	Moderate interference	15	Mild interference
2	Mild interference	9	Moderate interference	16	Mild interference
3	Mild interference	10	Moderate interference	17	Mild interference
4	Mild interference	11	Mild interference	18	Mild interference
5	Moderate interference	12	Mild interference	19	Mild interference
6	Moderate interference	13	Mild interference	20	Mild interference
7	Moderate interference	14	Mild interference		

Analysis of the impact of tourism distance on vegetation landscape

The overall impact of tourism activities on the vegetation landscape is minimal, but greater on the local areas, which is manifested in the trampling and picking of the vegetation by tourists, resulting in the inhibition of the growth and development of the vegetation and the change of the vegetation coverage. Water and soil pollution caused by tourism activities will also affect the growth and development of vegetation.

In this experiment, the vegetation coverage and species diversity are taken as evaluation index. With 10 sample plots in total, each sample plot comprises four samples, with a size of 1 m × 1 m, and the distances of the four samples to the tourism path are 0 m, 5 m, 10 m and 15 m, respectively. Taking relative coverage as the research object, the richness index of species is as follows:

$$R = (S - 1) / \ln N \quad (\text{Eq.2})$$

where, S represents the total number of species in a single sample and N represents the sum of species importance values in all test samples.

Figure 7 shows the relative coverage of the vegetation and the change of the species number in the samples with different travel distance.

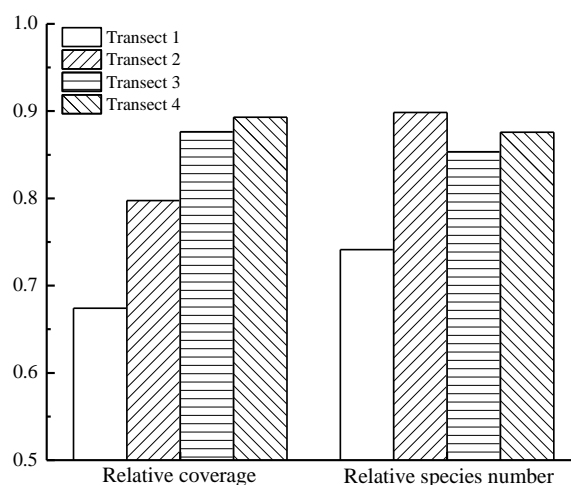


Figure 7. Changes in relative coverage and species of vegetation distance from different tourism activities

It can be clearly seen that the relative coverage of the vegetation and the change of the species number show different changing law. The further the tourist path is, the larger the relative coverage of the vegetation is. The number of species in the sample with the distance of 0 m to tourist path is the least, the number of species in the sample with the distance of 5 m is the largest, and the number of species in the samples 3 and 4 is less than that of the sample 2, that's, the vegetation diversity increases not far from the distance from the tourist path, which may be related to the "moderate interference hypothesis". *Figure 8* shows the degree of tourism interference in different tourism distance zones and the coverage ratio, the height relative ratio and the vertical structure of the vegetation show the same trend, and the smaller the travel distance is, the larger the coverage ratio, the height relative ratio and the vertical structure value of the vegetation are, which is opposite to the changing law of the interference degrees, and the interference degree decreases with the increase of the travel distance, which conforms to the natural law.

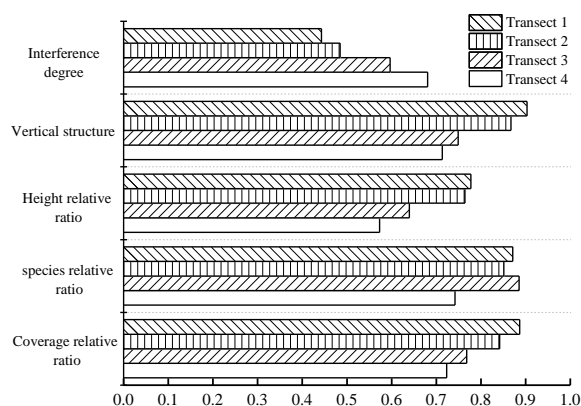


Figure 8. Different tourist distances with tourist interference

Discussion

Ecological response of environmental quality to the interference of tourism activities

Environmental quality is also an important index to measure the environment of ecological nature reserves. Air pollution, water pollution and noise pollution will all affect the soil, vegetation and animals in the nature reserves. In this paper, three indexes of atmospheric pollutants such as CO, ammonia nitrogen and total suspended particulate matter are tested. *Table 4* shows the monitoring results of the main atmospheric pollutants in Wuyishan National Nature Reserve.

Table 4. Monitoring results of major atmospheric pollutants in Wuyishan National Nature Reserve

Project	CO	Ammonia nitrogen content	Suspended particulate matter
Jiu Quxi	0.015	0.016	0.124
Da Zangfeng	0.014	0.010	0.099
Fu Rongtan	0.015	0.006	0.089
Wo Longfeng	0.014	0.008	0.065
Mean	0.0145	0.010	0.0943
National standard	0.05	0.05	0.12

Compared with the national natural standards, the overall environmental quality of Wuyishan National Nature Reserve is the first-class standard, but the total suspended particulate matter content of Jiuqu River is higher than the first-class standard. *Figure 9* shows the changing value of total suspended particulate matter concentration in different places. The fluctuation of total suspended particulate matter concentration in Jiuqu River is the most obvious, with the highest concentration value at 16 pm, mainly because passengers returning from other scenic spots successively view Jiuqu River, and the vehicles pass frequently, causing a gradual increase in the concentration value.

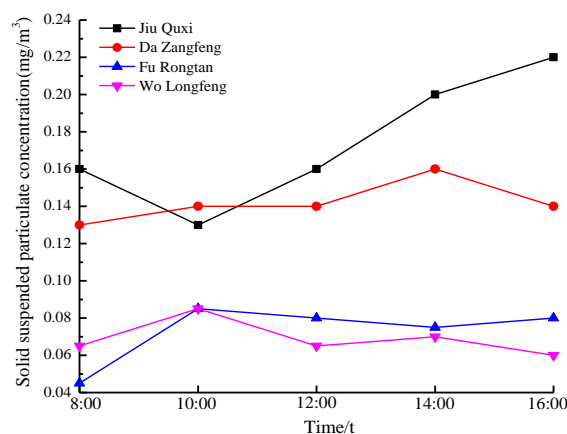


Figure 9. Increasing values of total suspended particulate matter at different locations

Measures for coordinated development of tourism activities and ecological nature protection

The impact of tourism activities on the environment of ecological nature reserves is inevitable. If tourism planning and management work is in place, the sustainable development of tourism activities and environmental protection can be realized. At present, the laws and regulations on tourism management in Wuyishan National Nature Reserve are not sound, the natural resources are seriously destroyed, and there is no necessary supervision and management system. In order to achieve ecological sustainability, we should strengthen the management of managers, operators and tourists. Tourists are the direct participants of tourism activities, so this paper will focus on the relevant management measures for tourists. First of all, tourists should manage and restrict their own behavior and put an end to uncivilized behaviors such as picking up, littering and painting in the reserves. Third, we should standardize tourism behavior, strengthen the popularization and education of ecological science in tourism activities, and ensure the harmony and unity of tourism activities and ecological environment. Finally, we should have meaningful tourism activities, implementing the eco-environmental protection and sustainable development throughout the tourism activities.

Conclusions

Taking Wuyishan National Nature Reserve as the research object, this paper explores the impact of tourism activities on environmental carrying capacity, vegetation landscape and atmospheric environment of natural ecological reserve. The specific conclusions are as follows:

The environmental carrying capacity of each index of Wuyishan National Nature Reserve is different greatly, and the carrying capacity of ecological environment is the largest. According to the current carrying capacity value, the total amount of tourists received in Wuyi Mountain exceeds the environmental carrying capacity of water resources.

The number of species in the sample with the distance of 0 m to tourist path is the least, and the number of species in the sample with the distance of 5 m is the largest. The coverage ratio, height relative ratio and vertical structure of vegetation show the same changing law, that's, the smaller the tourist path distance is, the larger the coverage ratio, height relative ratio and vertical structure value of vegetation are, which is opposite to the changing law of interference degree value. The interference decreases with the increase of the tourist path distance.

The larger the interference of tourism activities is, the smaller the ecological benefit value of the tested sample is. The result of testing the atmospheric pollutants shows that the impact of tourism activities on the atmospheric environment is small.

At present, the calculation of environmental carrying capacity is based on the intensity of tourist source activities. No quantitative analysis was made on whether tourism will affect the atmospheric environment and water environment of Wuyishan Ecological Nature Reserve, and the degree of the impact, so the scientific quantitative research and analysis can be carried out in the future.

Acknowledgements. Heilongjiang Natural Science Foundation (QC2017086); Heilongjiang Youth Innovative Talents Project (UNPYSCT-2017174); Suihua University of Cold Black Soil and Culture Research Project (H201701002); Suihua University of Applied Research Project (Y201701002); Suihua University of Scientific Research and Innovation Team (SIT04B003).

REFERENCES

- [1] Buswell, R. J. (2011): Mallorca and tourism: History, economy and environment.
- [2] Giddy, J. K., Webb, N. L. (2015): The influence of the environment on motivations to participate in adventure tourism: the case of the tsitsikamma. – *South African Geographical Journal* 98(2): 351-366.
- [3] Hanna, P., Johnson, K., Stenner, P., Adams, M. (2015): Foucault, sustainable tourism, and relationships with the environment (human and nonhuman). – *GeoJournal* 80(2): 301-314.
- [4] Hayward, P., Kuwahara, S. (2013): Divergent trajectories: environment, heritage and tourism in tanegashima, mageshima and yakushima. – *Journal of Marine and Island Cultures* 2(1): 29-38.
- [5] Hjalager, A. M., Johansen, P. H. (2013): Food tourism in protected areas sustainability for producers, the environment and tourism. – *Journal of Sustainable Tourism* 21(3): 417-433.
- [6] Jurigová, Z. (2016): Tourism: new destination of global business environment. – *International Advances in Economic Research* 22(3): 351-352.
- [7] Kennedy Nyahunzvi, D. (2015): Negotiating livelihoods among chivi curio traders in a depressed zimbabwe tourism trading environment. – *Anatolia* 26(3): 397-407.
- [8] Kruczek, Z., Michał, K. (2016): Post-industrial tourism as a means to revitalize the environment of the former oil basin in the Polish Carpathian mountains. – *Polish Journal of Environmental Studies* 25(2): 895-902.

- [9] Mirela, S., Butnaru, G. I. (2015): Research on tourists' perception of the relationship between tourism and environment. – *Procedia Economics and Finance* 20: 595-600.
- [10] Movono, A., Dahles, H., Becken, S. (2018): Fijian culture and the environment: a focus on the ecological and social interconnectedness of tourism development. – *Journal of Sustainable Tourism* 26(3): 451-469.
- [11] Popp, P. K. (2014): Vacationland: tourism and environment in the colorado high country. – *Journal of American History* 101(1): 350-351.
- [12] Ritter, F. (2009): The encyclopedia of tourism and recreation in marine environments. – *Annals of Tourism Research* 36(3): 538-539.
- [13] Tikkanen, J., Hokajärvi, R., Hujala, T., Kurttila, M. (2017): Ex ante evaluation of a pes system: safeguarding recreational environments for nature-based tourism. – *Journal of Rural Studies* 52: 42-55.