The effect of tourism human disturbance on soil ecological environment: a comprehensive data analysis study (#79893)

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The effect of tourism human disturbance on soil ecological environment: a comprehensive data analysis study

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[Objective]The paper concerns the response law of different tourism interference levels to the soil ecological environment of baligou scenic spot, and to provide scientific basis for the rational development of eco-tourism planning and eco-environmental protection and management of baligou scenic spot.[Methods] combined with field collection and laboratory physical and chemical data analysis, the impact of tourism interference on soil ecological environment in baligou scenic spot was analyzed.[Conclusion] human factors in the process of tourism activities in baligou scenic spot have a certain impact on the physical aspects of the scenic spot, such as soil specific gravity, hue and chroma, porosity, compactness, capacity and deciduous layer, as well as pH value, soil enzyme activity, organic matter and soil heavy metals. The overall data show that the dynamics of soil indicators are background zone < buffer zone < interference zone. Due to the influence of human trampling and infrastructure construction, the contents of Pb and Cr in the sample soil change regularly, and the contents of other heavy metals are lower than the national standard. The maximum range of Sri soil ecological environment comprehensive response evaluation index is A1 interference area SIR = 4.679 and C1 background area SIR = 1.263 respectively. The interference response level of the scenic spot's soil biological environment to tourist activities is higher the higher the value of the Sri response index, which measures how much of an influence and how negatively tourism activities interfere with that environment. Activities for the promotion of tourism that are appropriate and moderate improve the picturesque area's soil quality. To prevent the reversible degradation of the soil ecological environment, it is advised to carry out appropriate ecological environment planning and implement specific macro solutions.so as to truly realize the win-win situation of ecological environment protection while developing tourism economy in the scenic spot.

The effect of tourism human disturbance on soil ecological environment: a comprehensive data analysis study

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Abstract

[Objective]The paper concerns the response law of different tourism interference levels to the soil ecological environment of baligou scenic spot and to provide scientific basis for the rational development of eco-tourism planning and eco-environmental protection and management of baligou scenic spot.[Methods] combined with field collection and laboratory physical and chemical data analysis, the impact of tourism interference on soil ecological environment in baligou scenic spot was analyzed.[Conclusion] human factors in the process of tourism activities in baligou scenic spot have a certain impact on the physical aspects of the scenic spot, such as soil specific gravity, hue and chroma, porosity, compactness, capacity and deciduous layer, as well as pH value, soil enzyme activity, organic matter and soil heavy metals. The overall data show that the dynamics of soil indicators are background zone < buffer zone < interference zone. Due to the influence of human trampling and infrastructure construction, the contents of Pb and Cr in the sample soil change regularly, and the contents of other heavy metals are lower than the national standard. The maximum range of Sri soil ecological environment comprehensive response evaluation index is A1 interference area SIR = 4.679 and C1 background area SIR = 1.263 respectively. The interference response level of the scenic spot's soil biological environment to tourist activities is higher the higher the value of the Sri response index, which measures how much of an influence and how negatively tourism activities interfere with that environment. Activities for the promotion of tourism that are appropriate and moderate improve the picturesque area's soil quality. To prevent the reversible degradation of the soil ecological environment, it is advised to carry out appropriate ecological environment planning and implement specific macro solutions.so as to truly realize the win-win situation of ecological environment protection while developing tourism economy in the scenic spot.

Introduction

Tourism scenic area is an important carrier for people's leisure and entertainment for tourism activities[1], and the quality of ecological environment of tourism scenic area directly determines the sustainable development of tourism scenic areas and the smooth implementation of tourism planning. With the improvement of people's living standards, the number of trips to tourist attractions has increased by leaps and bounds. Human interference has caused certain pressure and damage to the carrying capacity of tourist scenic spots[2], and a series of irreversible soil environmental pollution problems such as slabbing, erosion, soil erosion and uneven distribution of trace elements in tourist scenic spots due to human trampling and other factors have become more and more obvious [3].

Bailigou Scenic Area is located in Hui County, Xinxiang City, Henan Province in the Central Plains hinterland, and is an important 5A national tourist scenic area in northern Henan Province, which has an important strategic significance in the ecological construction pattern of high-level tourist scenic areas in Henan Province. As Bailigou Scenic Area was selected as a national 5A tourist scenic area in December 2019, the peak number of visitors was significantly higher than in previous years, thus causing great pressure on the carrying capacity of the tourist scenic area. The edge of the tourist scenic area and the core play area soil surface is affected by different degrees of human trampling[4], the soil ecological environment has been greatly damaged, causing a certain resistance to the sustainable development of the ecological environment of the tourist scenic area, which will further cause a risk of reducing the high quality and high value of tourism products to the various natural tourism resources of the tourist scenic area[5]. Once the natural resources are damaged and polluted, the cost of further restoration and purification is too high.

The current research related to soil ecology in scenic areas has become a hot spot in regional tourism research. Domestic and international studies have shown that tourism disturbances have had far-reaching effects on soil organic matter, acidity and soil erosion[6-11]. However, these studies mainly focus on the measurement and comparison of soil physical and chemical properties in scenic areas, the research index factors are relatively single and general, the correlation study of the impact of different disturbance intensity and regional influence on soil ecological environment is insufficient, and the study of the response of tourism disturbance on soil ecological environment in central mountainous scenic areas is still lacking. Especially, the research on soil ecological environment of South Taihang Mountains along the Yellow Basin is still in a blank field. Therefore, it is important to understand the response law of soil ecological environment in Bailigou scenic area on different tourism disturbance strengths and weaknesses, in order to provide scientific basis for rational development of Bailigou scenic area ecotourism planning and scenic area ecological environmental protection and management.

2. Research Area

Baligou Scenic Area is located in the northwest of Xinxiang City, Henan Province, in the center of the hinterland of northern Henan. The overall planning covers an area of 109 square kilometers. The Baligou scenic spot mainly includes three parts: Baligou Tourist Area, Tianjie Mountain Tourist Area and Jiulian Mountain Tourist Area. The scenic spot belongs to the warm temperate continental monsoon climate, which is affected by the trend of the South Taihang Mountains and the altitude of the scenic mountains, and the monsoon effect is obvious. The four seasons are distinct and the climate is pleasant. The average annual temperature is 12℃～14℃. It is the first choice for tourists from all over the country to escape the summer heat. The annual precipitation is 576.6mm, and the frost-free period is 214 days throughout the year. The annual average sunshine time is 2020.1 hours. The soil in the scenic spot belongs to cinnamon soil and brown loam soil, and the forest coverage rate of Baligou scenic spot is as high as 90%. The soil profile layer is more obvious, and the soil texture is more sticky and heavier than that of other plain areas.

The Baligou Scenic Spot contains a variety of typical temperate deciduous broad-leaved trees that are bountiful in biological resources. The picturesque area combines key appealing characteristics, such as the essence of the South Taihang Scenic Area's sceneries, with tourist resources, such as lovely valleys, forest trails, health and leisure opportunities, and cultural heritage. It draws an increasing number of people as a well-known national 5A-level tourism destination. In 2019, more than 1.6 million people visited the magnificent area each year.

3. Materials And Methods

3.1. Quadratic Setup And Soil Sample Collection

This Duan Guilan, Shi Qiang, Li Mei, Lu Lin [12-15] and others have shown in their studies that tourists in the scenic spot have a great impact on the physical and chemical properties of the soil within 3 meters of the extension of the scenic trail through trampling and other artificial disturbances. The physical and chemical properties of soil samples in the extension area did not change significantly. Therefore, according to the characteristics of appearance factors such as the geographic location of Baligou scenic spot, the direction of the trails, and the distribution space of core scenic spots, this study selected 6 soil sampling points, located in (2 in Baligou tourist area, 2 in Tianjieshan tourist area, There are 2 Jiulianshan tourist areas), a total of 18 different points are distributed in the scenic area. The selected sampling points are basically located near the main core scenic spots and tourist service centers, and the sampling points of the Baligou tourist area are selected in the Tianhe Waterfall and the tourist service center section. The sampling points of the Tianjie Mountain tourist area are selected in the Laoye top scenic section and the tourist service center section. The sampling points of the sample plot in the Jiulian Mountain tourist area are selected in the Xilian Temple in the Xiaoxi Tianjing Section and the central section of the Xilianxia Scenic Spot. The distribution map of sampling locations is shown in Figure 1. Set the sample belt along the vertical direction of the main tourist trail of the scenic spot, and select the main tourist trail in each tourist area with 0.1-2m (tourism activity interference area), 3-5m (tourist activity buffer area) and 6-10m (tourist activity background area). 1m × 1m quadrat. In each transect along the travel trail, in each selected sample quadrat of activity disturbance, according to the small quadrat with an area of 10cm × 10cm, use soil sampling tools to collect the surface soil of 0-12cm in the sample area in the target area, and take the sample. The amount of soil was 500g per sample point, and samples were taken in polyethylene sample bags, and each sample was numbered. The soil samples taken from the soil samples were screened for stones and animal and plant residues, and preliminary micro-treatment was carried out. The samples were sealed in the original soil and placed in the laboratory for natural air-drying, and the regular analysis of the physical and chemical properties of the soil in the scenic spot was carried out in the later period.

3.2.Determination of soil physical and chemical properties

The pH of the soil samples in the scenic area was measured by potentiometric method (the ratio of water-extracted soil liquid was 2.5:1); the soil firmness index was measured by a firmness meter, and the measurement was based on the GB 7843-1987 Determination Standard for Forest Soil Firmness; soil natural moisture content Measured by drying method at 110℃, soil brightness was measured by comparison with Mensell soil color chart. The external heating $K_2Cr_2O_7$ bulk density ratio method was used to determine the ecological content of soil organic matter. Soil organic matter content was determined by potassium dichromate method (chemical oxygen demand was determined by reducing substances in oxidized samples). The content of heavy metals in soil was determined by ICP-MS inductively coupled plasma mass spectrometer. For specific detection methods, please refer to references [16-18].

3.3.Construction of soil ecological environment response evaluation model

3.3.1. Construction of single factor response model

Affected by the human interference factors of external tourists and the natural factors of the scenic spot itself, combined with the base point of the scenic spot's carrying capacity, the soil quality is affected by a single factor. The increase and decrease of its influencing factors were mainly analyzed through soil collection at sample sites.

3.3.2. Soil ecological environment comprehensive response evaluation index model

The impact of tourism disturbance on the soil ecological environment is multi-dimensional. This study comprehensively considers the soil single-factor response evaluation, combined with the processing and analysis of related data. According to the comprehensive evaluation model of soil environment proposed by Qin Yuanhao and Xie Deti. In this way, the comprehensive response of different influencing factors to the soil ecological environment of Baligou scenic spot under different tourism disturbance intensity was evaluated. The index evaluation model is expressed as:

$$SRI = \sum_{i=1}^{i^{-1}} w_i \sum_{j=1}^{9} \frac{S_{ij} - S_{oj}}{S_{oj}} \quad (1)$$

Among them, it represents the comprehensive response evaluation index of the soil ecological environment of the scenic spot; j represents the number of indexes of influencing factors, taking 9 weight indicators such as soil bulk density, water content, porosity, soil compactness, pH value, soil pH, enzyme activity and organic matter. ; is the measured value of the jth impact factor in the ith sample soil.

3.4.Analysis and processing of experimental data

Excel software was used to analyze and process the sample data, and the single-factor response model was first constructed for soil samples in different partitions, and then the data analysis of the soil ecological environment comprehensive response evaluation index model was carried out.

The weight of each index factor was determined by the factor analysis of multivariate statistics and the analysis of the comprehensive response evaluation index to characterize the soil quality of the plot. The correlation test of statistical data was completed using the data statistical software *SPSS 19.0*, and the visualization maps such as the study area were drawn with *ArcGIS 10.5* version.

4. Results And Analysis

4.1.The influence of tourism disturbance on soil physical properties

4.1.1. Response of leaf litter and soil brightness to tourism disturbance

In the selected 6-10m background area of tourism activities in the scenic transect, through the observation of the soil surface and vertical section of the background area, it can be seen that the vegetation on the soil surface is well protected, and there are generally residual litter on the soil surface. The thickness of the obtained data generally ranges from 0 to 4 cm (Table 1). There is a humus layer of about 2 cm in some samples in the outer edge area. The litter layer is sensitive to tourism disturbance. The reason may be that the litter layer is attached to the soil surface and has a loose structure. Environmental conditions such as tourism trampling, manual cleaning and even strong wind will affect the accumulation and decomposition of the litter layer process.

In the disturbed area of tourist activities with frequent tourist activities, due to the presence of tourist trampling and tourist garbage, the erosion of the soil surface is more obvious, the surface of the severely disturbed area is exposed, and some soil surface layers appear rocky desertification. The amount of vegetation on the soil surface and the soil profile Decreasing leaves. Due to the reduction of vegetation and tree leaves, the decayed rot layer of animals and plants causes the organic matter content of soil components to decrease, thereby causing the increase of soil brightness and chroma. The vegetation and litter are basically invisible, and the root system is obviously reduced compared with the background area. In the disturbed area of tourism activities, vegetation and litter decreased, resulting in a decrease in soil organic matter content and an increase in soil brightness and chroma.

According to soil color and cross-sectional shape, the change law of soil performance is discernible. Soil color is one of the most significant sexual features to notice in soil morphological characteristics.

Soil color is one of the most important sexual characteristics to observe soil morphological characteristics, and the change law of soil performance is detected according to soil color and cross-sectional shape. The soil brightness was compared using the Mensell soil color chart, and it was found that the color of the surface soil in the sample area of Baligou in the wet state was as follows: brown (7.5YR4/3), but the buffer zone and background area are relatively less affected by human interference, and the soil color has changed from brown to dark brown (7.5YR3/3) and dark brown (7.5YR2 /2) after color card comparison data(Table 1).

4.1.2. The response of soil bulk density to the disturbance of tourism trampling

The SPSS analytic program was used to sort and analyze the sample data from the disturbance region, buffer area, and background area. The findings indicated that soil bulk density increased in a favorable direction as tourist disturbance intensity increased. The soil bulk density exhibits a decreasing tendency as one travels more and farther from the touristy region. Table 2 displays the results of the collection and examination of the particular soil samples.

4.1.3. The response of soil water content to the disturbance of tourism trampling

By drying the soil at 110° C, the natural soil moisture content was identified. The sample data were then organized and examined. Table 2 displays the information the soil samples provided.

It can be seen from Table 2 that the data analysis and sorting through the analysis software SPSS shows that the soil moisture content in the disturbance area with large tourist activity is the lowest (30%), followed by the buffer zone, and the background area has the highest water content (67%).

4.1.4. Response of soil porosity to trampling disturbance

One of the key metrics for assessing soil structure is soil porosity. The looseness of the soil in the picturesque location and the greatest amount of air and water that may be accommodated are both determined by the porosity of the soil. If the soil porosity is smaller, the soil capacity is smaller, and the soil is compact and not loose. On the contrary, the opposite is true. By comparing the samples in the interference area, buffer area and background area, it is found that the soil porosity in the background area is much larger than that in the interference area and buffer area (Fig. 1). It shows that the background area with long distance interval has larger soil capacity, loose soil and good soil structure.

4.1.5. Response of soil compaction to trampling disturbance

One of the key components of the depiction of soil attributes is soil compaction, commonly referred to as soil hardness or soil penetration resistance. Sampling and data reading of the soil in the sample region revealed that the interference area, buffer zone, and background area of soil compaction were all present(Figure 1). The soil hardness in the disturbance zone is much greater than that in the background zone and buffer zone. The data show that in the background area spaced far away, the soil hardness is the least, the soil is loose, and the soil structure is in good condition. The soil hardness in the interference area with a large value is relatively large, and compacting the soil will prevent the infiltration of water, thereby reducing the absorption and utilization rate of soil water and fertility, and further affecting the growth of plant roots in the scenic area.

4.2.The influence of tourism disturbance on soil chemical properties

4.2.1. Response of soil pH to tourism disturbance

The sampling results of the sample area showed that the soil pH value was the highest in the disturbance area with dense tourists. With the increase of the edge distance, the pH value of the soil chemical properties in the sample area decreased due to the reduction of human interference factors such as tourists trampling on the background area (Fig. 1). The results of multiple comparisons showed that the pH of soil samples was in the order of tourism interference area > buffer zone > background area.

Human disturbances such as trampling by tourists will damage the vegetation and litter layers on the soil surface, resulting in a decrease in soil moisture content and loam organic matter content. These factors may lead to changes in soil *pH*. Secondly, the number of tourists in Baligou Scenic Spot is larger than that of Jiulian Mountain and Tianjie Mountain, and the effect of tourists' trampling is significant. Building construction and alkaline building residues in Baligou Scenic Spot are serious, which is also the reason for the high pH value in the disturbed area of Baligou Scenic Spot.

Data collection and analysis of sample regions in various parts of the nice location reveal that soil enzyme activity responds more visibly to tourist disturbance (Figure 2). The invertase and catalase activities in the soil demonstrated that the interference region was noticeably larger than the background area and that the interference area was greater than the buffer area and the background area.The exact reverse is true in terms of urease activity performance, suggesting that the interference region, buffer area, and background area are all less than the long-distance background area. Alkaline phosphatase activity was less modified by human interference, and the results demonstrated no notable changes.

4.2.3. Response of soil organic matter to tourism disturbance

Organic Organic matter is an important factor affecting soil fertility. The proportion of organic matter in soil is directly related to soil properties and surface vegetation nutrition. The treading and picking activities of tourism activities cause serious damage to the litter layer and humus layer of trees in forest areas, which directly leads to the relative reduction of the amount of plants returned. At the same time, the compactness of soil compacted by tourism activities such as trampling directly affects the growth and development of plant roots, which will cause the decrease of organic matter content. In addition, the change of soil physical and chemical properties will reduce the number of some animals and microorganisms beneficial to the soil, and also lead to the reduction of soil organic matter content in the local soil. With the increase of the distance from the walking path in the sampling zone, the content of organic matter in the soil increased. The results of multiple sample comparisons of the six sample areas showed that the disturbance area was significantly affected, while the variation range of data in the background area and buffer zone was small (Table 3). Human disturbance such as tourist trampling reduces the content of organic matter in the soil.

4.2.4. Response of soil heavy metal content to tourism disturbance

The conclusions of the extraction and comparison of the soil's heavy metal content in the sample area demonstrate that the levels of the heavy metallic components Hg, Cd, As, Pb, and Cr are all low and that the comparative content is below the national standard limit in the three tourism attractions.However, due to the influence of human trampling and infrastructure construction in the sample area, the content of Pb and Cr in the sample soil showed a regular trend. The data in Table 4 shows that the highest value of Pb interference area is 29.434$mg \cdot kg^{-1}$, and the minimum value is 20.016 /$mg \cdot kg^{-1}$

The overall performance is interference area>buffer area>background area, and its regular performance is that the concentration of the heavy metals Pb and Cr in the soil increases with proximity to the main trail, as well as with the level of human involvement.

4.3.The Evaluation of soil ecological environment comprehensive response evaluation index model

In Baligou sample A1 area and Jiulianshan sample C1 region, respectively, the highest range of the SRI Thorough Response Evaluation Index of Soil Ecological Environment was SRI=4.679 and SRI=1.263.

In associated with data analysis, the higher the value of the SRI response index, the greater the impact and terrible effect of the disturbance of tourism activities on the soil ecological environment of the scenic area, and the higher the disturbance response level of the scenic area's soil ecological environment to tourism activities. On the other hand, there is less of an effect of tourism activities on the physiological environment of the soil.

As can be shown, the quantity to which tourist activity interference affects Baligou Scenic Spot's ecological environment and the degree to which soil ecological environment interference influence tourism activity range from high to low:interference zone (*A1 > B1 > A2 > B2 > C2 > C1*), buffer zone (*A1 > A2 > B1 > C1 > B2 > C2*), background zone(*A1 > A2 > B1 > C1 > B2 > C2*) (Table 5). The highest *SRI* data was found in the disturbed area, and the lowest was in the background area. The *SRI* data of the soil ecological environment comprehensive response evaluation index in the disturbed area was higher than that in the background area. It indicates that the greater the impact and negative effect of tourism activities on soil ecological environment, the higher the response level of soil ecological environment to tourism activities.

5. Discussion

5.1.The Response of soil physical and chemical indicators to tourism disturbance

(1) Through the information collection and analysis of soil samples, it has been shown that in areas where human activity interferes with tourism, the number of visitors increases the severity of soil interference in picturesque areas, and the pH value of the soil gradually rises. The findings of several comparisons demonstrated that the pH disturbance zone of soil samples was greater than the buffer zone and background zone. The prime reason is that human intervention, such as tourist trampling, harms the litter layer and soil surface vegetation, resulting in serious soil compaction and a reduction in soil surface vegetation, which in turn causes soil erosion, a decline in soil water permeability, and a relative increase in the pH value of the soil's alkaline enhanced state.

(2) With the increase of tourist disturbance behaviors, the soil aeration in the scenic area is weakened, and the soil compaction degree is increased. Human disturbance led to the exposed soil surface in some trampled areas, and the petrochemical phenomenon was obvious. Dead roots and fallen leaves and human trampling resulted in the reduction of plant roots and the deterioration of the humus layer, which eventually led to the soil organic matter content in the soil disturbance area of the scenic spot being much lower than that in the background area.

(3) With the increase of the distance from the walking trail to the sampling belt, the content of organic matter in the soil increased. The comparison results of multiple samples in the six sample areas showed that the interference area was significantly affected, and the data changes in the background area and the buffer area were relatively large. Small. Tourists trampling and other tourist disturbances reduce the content of organic matter in the soil of the scenic spot.

(4) The invertase activity and catalase activity in the soil showed that the interference area was significantly higher than the background area, and it was shown as interference area>buffer area>background area. The urease activity performance is the complete opposite, demonstrating that the long-distance background space is greater than the interference area and the buffer area.that is, the interference area<buffer area<background area. Alkaline phosphatase activity was less affected by human interference, and the data showed no obvious fluctuations.

(5) The contents of Hg, Cd, As, Pb and Cr in the soil of the sample area are relatively small, and the comparative contents are all lower than the national standard limit. However, due to the influence of human trampling and infrastructure construction, the Pb and Cr content in the sample soil showed a regular trend, the overall performance was interference area > buffer zone > background area, and its regular performance was the distance from the main trail. The more recent, the higher the intensity of human interference, the higher the corresponding content of soil heavy metals Pb and Cr.

(6) Combined with data analysis, the impact intensity of tourism activities on the ecological environment of Baligou Scenic Spot, the disturbance response level of the soil ecological environment in the scenic area to tourism activities from high to low is: interference zone (A1 > B1 > A2 > B2 > C2 > C1), buffer zone (A1 > A2 > B1 > C1 > B2 > C2), background zone(A1 > A2 > B1 > C1 > B2 > C2). It shows that the soil ecological environment responds to tourist activities more strongly the bigger the influence and the impact of tourism activities on the environment. On the other hand, the level of the soil ecological environment's response to tourist activities decreases as the influence of tourism activities on the environment is reduced.

5.2.The Analysis of strategies to reduce the response of scenic soil ecological environment to tourism disturbance

5.2.1. Combined with the integration model of tourism + ecological disciplines, the internal and external adjustment of ecological scenic spots

At the time node of long and short vacations, tourists in the scenic spot tend to spout during the holidays, and then the interference of human factors causes pressure and damage to the natural ecological environment of the scenic spot [19]. Zhu Jiawei, Zhang Guanghai[20, 21] pointed out in the relevant literature that in the peak tourist season, tourists should be guided and separated in time and space, and the number of tourists during peak periods should be strictly controlled to avoid excessive interference by tourists and exceed the self-purification of the soil ecosystem in the scenic area. ability to cause irreversible damage to the soil ecological environment. In terms of internal factors, the interference effect of ecology on the carrying capacity of the ecological environment should be actively explored, and the physical and chemical properties of the scenic soil should be tested experimentally according to the integration of tourism, soil science and ecology to further determine its response to the soil ecological environment. It provides a scientific basis for the rational development of scenic eco-tourism planning and the ecological environment protection and management of scenic spots.

5.2.2. Reasonably plan the ecological layout of scenic spots and strengthen spatiotemporal monitoring of soil environment

On the basis of the original distribution of scenic spots in the scenic spot, rationally plan the layout of its functional divisions, and fully consider the habits and diffusion characteristics of tourists. Through the analysis of tourists' space routes, functional areas such as scenic trails, sightseeing bridges and rest areas can be reasonably planned. For example, the construction of "return" type tourist loops and gridded wide tourist trails can effectively divert and evacuate crowded people, and avoid excessive concentration of tourists and excessive trampling on the soil in local areas of the scenic spot, resulting in strong negative interference to soil performance. . At the same time, it advocates the concept of green ecology and environmental protection, compares the materials of the trails, lays durable wooden boards, pebbles, bionic wood and stone materials, and sets up extended railings to reduce the ecological damage to the extended area of the trail caused by travel interference.

The main reason for the decline of soil environmental quality in scenic spots caused by tourists' human disturbance is external factors such as human trampling[22]. The passenger flow is monitored in real time. If the passenger flow is large, the carrying capacity of the soil environment may be insufficient, and the passenger flow will be evacuated in time. While monitoring the passenger flow, various index factors (soil compactness, porosity, pH and litter layer thickness, etc.) of the soil in the scenic area are monitored, and remedial response measures are taken in time for changes in soil environmental factors.

5.2.3. Strengthen the publicity and cultivation of environmental awareness and increase public participation

While experiencing the physical and mental enjoyment brought by the natural environment of the scenic spot, tourists strengthen their awareness of ecological environmental protection[23]. Encourage residents around the scenic area to feel the feedback ecological and economic benefits brought about by protecting the ecological environment by participating in the development and management of natural ecological resources in the scenic area. Through the words and deeds of the scenic spot managers and destination residents, the surrounding propaganda and education are formed to the tourists, so as to improve the tourists' consciousness of protecting the natural ecological environment of the scenic spot, and advocate the instillation of green tourism, eco-tourism and low-carbon tourism awareness, so as to reduce the risk of Excessive disturbance and destruction of scenic spots.

5.2.4. Introduce ecological improvement governance system to improve soil ecological balance

Taking into account the negative impact of tourists' trampling and other factors on the soil in the scenic area, especially in the case of tourist disturbance areas, soil ecological improvement techniques in forest areas, ecological farmland or paddy fields should be introduced. At present, soil improvement technologies and methods are relatively concentrated in farmland irrigation and water conservancy improvement technology, biological improvement technology to prevent soil erosion by planting green manure, and chemical improvement technology to interfere with soil pH[24-25]. The soil ecology of the scenic spot is systematically managed through soil improvement techniques and methods, so as to achieve the balance of the soil ecological environment.

6. Conclusions

In 2019, Baligou Scenic Spot was rated as a national 5A-level scenic spot through the quality rating of the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, and its popularity has become higher and higher. . Studies have shown that the Baligou scenic area has caused certain disturbance and damage to the soil bulk density, compactness, pH value, moisture content and chemical organic matter content of the soil in the scenic area due to human interference factors such as tourists' trampling, picking and basic construction of tourist attractions. It has caused certain resistance to the sustainable development of the ecological environment of tourist attractions. Therefore, it is recommended to carry out reasonable ecological planning for the scenic spot, take certain macro-solution measures to prevent the retrograde deterioration of the soil ecological environment, and truly realize the win-win situation of ecological and environmental protection while developing the tourism economy in the scenic spot.

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Table 1(on next page)

Response data of soil compactness, porosity and soil pH to tourism disturbance

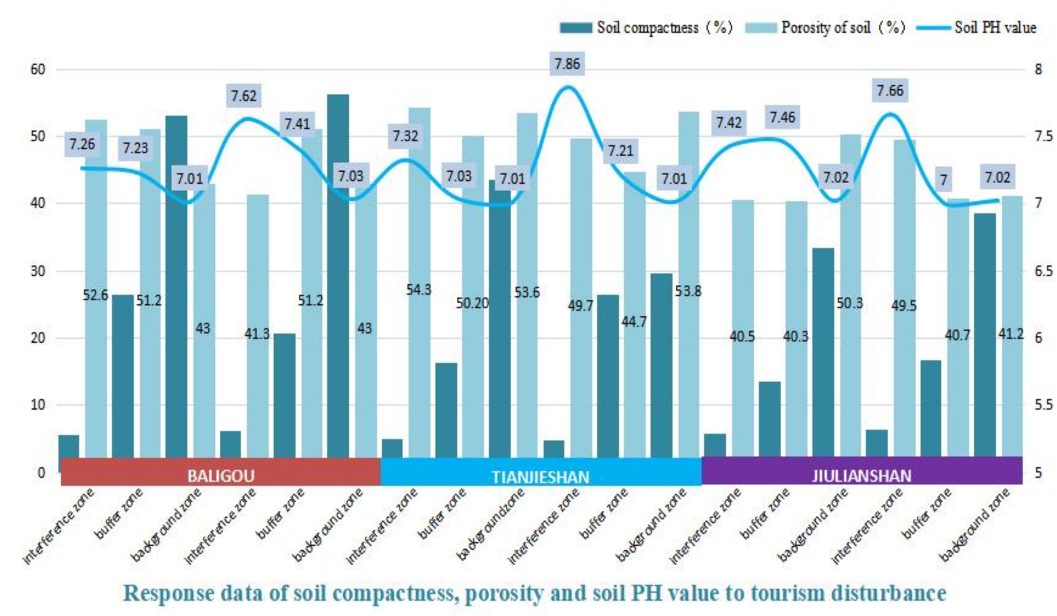

Figure 1. Response data of soil compactness, porosity and soil PH value to tourism disturbance

Table [illegible] (on next page)

Response data of soil enzyme activity to tourism disturbance

Figure 2. Response data of soil enzyme activities to tourism disturbance

Table 3 (on next page)

Response data of litter fall and soil brightness to tourism disturbance

Table 1. Response data of litter and soil brightness to tourism disturbance

Sample Area	sample zone	sample	Thickness of fallen leaves/*cm*	soil color
Baligou Sample Area A1	interference zone	A1	0	brown(*7.5YR4/3*)
	buffer zone	A2	1	dark brown(*7.5YR3/3*)
	background zone	A3	2	dark brown(*7.5YR2/2*)
Baligou Sample Area A2	interference zone	A4	0	dark brown(*7.5YR3/3*)
	buffer zone	A5	1	Old dark brown(*7.5YR3/1*)
	background zone	A6	3	black(*7.5YR2/1*)
Tianjieshan sample Area B1	interference zone	B1	0	reddish brown(*2.5YR4/8*)
	buffer zone	B2	2	reddish brown(*2.5YR3/4*)
	background zone	B3	4	Verydarkru sset(*2.5YR2/2*)
Tianjieshan sample Area B2	interference zone	B4	0	dark reddish brown(*5YR3/4*)
	buffer zone	B5	1	Verydarkru sset(*5YR3/3*)
	background zone	B6	3	dark brown(*5YR2/2*)
Jiulianshan sample Area C1	interference zone	C1	0	reddish brown(*5YR4/4*)
	buffer zone	C2	1	dark reddish brown(*5YR3/3*)
	background zone	C3	3	dark brown(*5YR2/1*)
Jiulianshan sample Area C2	interference zone	C4	0	reddish brown(*5YR4/4*)
	buffer zone	C5	2	reddish brown(*5YR3/3*)
	background zone	C6	3	reddish brown(*2.5YR3/4*)

Table 4(on next page)

Response data of soil water content to trampling disturbance

Table 2. Response data of soil moisture content to trampling interference

Sample Area	**sample zone**	**sample**	**soil moisture content**	**Soil bulk density**($g\cdot cm^{-3}$)
	interference zone	A1	30%	129.6
Baligou Sample Area A1	buffer zone	A2	37%	108.4
	background zone	A3	62%	101.3
	interference zone	A4	32%	119.6
Baligou Sample Area A2	buffer zone	A5	38%	98.4
	background zone	A6	67%	91.2
	interference zone	B1	32%	132.5
Tianjieshan sample Area B1	buffer zone	B2	41%	116.1
	backgroundzone	B3	62%	100.3
	interference zone	B4	30%	131.6
Tianjieshan sample Area B2	buffer zone	B5	43%	109.3
	background zone	B6	66%	100.6
	interference zone	C1	31%	132.3
Jiulianshan sample Area C1	buffer zone	C2	46%	123.6
	background zone	C3	63%	103.3
	interference zone	C4	32%	136.6
Jiulianshan sample Area C2	buffer zone	C5	43%	115.4
	background zone	C6	65%	102.6

Table 5 (on next page)

Responses of Soil Hydrolyzed Nitrogen and Organic Matter to Tourism Disturbance

Table 3. Response of soil hydrolyzed nitrogen and organic matter to tourism disturbance

Sample Area	sample zone	sample	organic matter/ $g\cdot kg^{-1}$	Hydrolysis nitrogen/ $mg\cdot kg^{-1}$
	interference zone	A1	2.017	56.83
Baligou Sample Area A1	buffer zone	A2	4.961	108.49
	background zone	A3	5.581	112.30
	interference zone	A4	2.435	63.52
Baligou Sample Area A2	buffer zone	A5	4.463	108.56
	background zone	A6	5.437	123.6
	interference zone	B1	2.325	85.81
Tianjieshan sample Area B1	buffer zone	B2	4.552	119.63
	backgroundzone	B3	4.962	131.64
	interference zone	B4	2.667	79.63
Tianjieshan sample Area B2	buffer zone	B5	4.451	121.30
	background zone	B6	5.029	136.52
	interference zone	C1	1.984	89.36
Jiulianshan sample Area C1	buffer zone	C2	4.361	121.68
	background zone	C3	4.989	165.32
	interference zone	C4	2.335	87.92
Jiulianshan sample Area C2	buffer zone	C5	4.667	119.67
	background zone	C6	5.883	173.82

Table 6(on next page)

Response data of soil heavy metal content to trampling disturbance

Table4. Response data of soil heavy metal content to trampling interference

Sample Area	Heavy metal	Heavy metal content/mg·kg^{-1}		
		interference zone	buffer zone	background zone
Baligou Sample Area A1	Hg	0.026	0.028	0.031
	Cd	0.103	0.071	0.067
	Pb	1.724	1.257	1.126
	Cr	27.636	27.109	23.124
Baligou Sample Area A2	Hg	0.031	0.041	0.033
	Cd	0.098	0.052	0.085
	Pb	3.426	2.138	1.438
	Cr	25.711	23.257	20.016
Tianjieshan sample Area B1	Hg	0.011	0.009	0.025
	Cd	0.099	0.091	0.021
	Pb	5.483	4.134	2.371
	Cr	20.654	18.015	17.108
Tianjieshan sample Area B2	Hg	0.038	0.019	0.014
	Cd	0.212	0.023	0.021
	Pb	4.065	3.216	1.072
	Cr	29.439	27.003	22.064
Jiulianshan sample Area C1	Hg	0.020	0.012	0.023
	Cd	0.101	0.036	0.014
	Pb	4.490	3.002	1.082
	Cr	28.331	22.146	23.017
Jiulianshan sample Area C2	Hg	0.019	0.023	0.012
	Cd	0.106	0.039	0.016
	Pb	4.382	3.165	1.094
	Cr	29.430	22.136	22.037

Table 7(on next page)

Soil ecological environment comprehensive response evaluation index SRI data

1 **Table5.** *SRI* data of comprehensive response evaluation index of soil ecological environment

Sample Area	**SRI data of comprehensive response evaluation index of soil ecological environment**		
	interference zone	**buffer zone**	**background zone**
Baligou Sample Area A1	4.679	3.106	2.031
Baligou Sample Area A2	4.016	2.884	1.869
Tianjieshan sample Area B1	4.362	2.039	1.866
Tianjieshan sample Area B2	3.356	1.986	1.452
Jiulianshan sample Area C1	3.296	2.013	1.751
Jiulianshan sample Area C2	3.433	1.897	1.263

2