Machine learning-based detection of mountain soil composition and environmental and ecological management of tourist areas

Aiping Wei

Received: 11 March 2021 / Accepted: 1 May 2021 / Published online: 18 May 2021
© Saudi Society for Geosciences 2021

Abstract
The soil sphere is located at the junction of the atmosphere, hydrosphere, lithosphere, and biosphere, and the flow of material and energy is very complicated. At the same time, this is the basic material condition necessary for the normal production and life of human beings. Traditional chemical substance detection methods cannot meet the development needs of modern agriculture. With the development of science and technology and the development of hyperspectral technology, large-scale dynamic and rapid monitoring of soil heavy metal pollution and soil fertility are carried out, and new ideas are provided. At the same time, because tourism is very harmful to the environment, the sustainable development of tourism requires the introduction of lasting and effective management. People have begun to explore the forms of tourism that can lead tourism on the path of sustainable development. The emergence of eco-tourism has helped to adjust the current contradiction between tourism and the environment, and it has also become an increasingly popular new tourism situation, which has led to rapid development. At present, the influence of eco-tourism is spreading all over the world. For this purpose, China has also carried out eco-tourism exploration, including the practice and theoretical research of eco-tourism in nature reserves. Only by fully considering the requirements of protecting the ecological environment can nature be respected and protected, and such actions can meet the requirements of ordinary people. In order to realize the harmonious coexistence of environment and tourism, based on the theory of eco-tourism, this article analyzes the development and management of ecotourism in China’s nature reserves without providing assistance for future tourism development.

Keywords Machine learning · Mountain soil composition · Tourist area · Environmental and ecological management

Introduction
Soil is composed of organic matter, microorganisms, granular minerals, water, air, and other loose substances on the earth’s surface. It is located at the boundary of the atmosphere, biosphere, resources, and hydrosphere, and is an important natural resource for agricultural production and the basis for energy. People’s lives provide important material security. Accurate detection of soil to protect the soil can provide help for the modern development of agriculture. With the advancement of science and technology, the world economy has entered a path of rapid development, accompanied by more and more serious ecological and environmental problems (Roslan et al. 2019). In order to promote and develop the path of ecological management, the Chinese government has developed ecological management and eco-tourism. It not only guarantees the complete development and utilization of tourism resources but also guarantees the principles of developing resources, reducing, reusing, and reducing, clearly reusing the tourism cycle economy during the tourism process (Rowell 2010) (Sadat-noori et al. 2013). Combine clothing, food, accommodation, transportation, entertainment, shopping services, and eco-tourism services in tourism activities to form an “eco-tourism package” to provide pollution-free and healthy eco-tourism services for the entire process (Shang et al. 2018).

Characteristics of ecotourism resources

Ecological characteristics

Originality Originality means that eco-tourism resources are relatively complete natural landscapes formed by nature, such
as forest grassland, karst caves, desert Gobi, sunny beaches, and biological resources Fig 1.

**Vulnerability** Ecotourism resources are not resources that can be continuously regenerated but are limited. If the limit is exceeded, the resources of eco-tourism will be destroyed and the ecological environment will deteriorate. This is the vulnerability of eco-tourism resources (Sharma et al. 1995).

**Comprehensive** Generally speaking, eco-tourism resources are a complex composed of natural factors such as topography, topography, climate, hydrology, vegetation, and animals (Singh and Goel 2011).

**Systematic** Ecotourism resources are interrelated, interdependent, and in an idle state. The system that makes those constituents organic is this relationship. This system has a unique ecological structure and energy flow, information flow, and material flow. As an element of this system, it can participate in this system and can also play a role in the cycle of this ecosystem (Smith 1999).

**Aesthetic features**

**Harmony** Harmony refers to natural resources with ecological beauty without artificial carvings. Or, human beings follow the laws of nature and establish a cultural ecosystem that is in harmony with nature.

**Viewability** Eco-tourism resources not only allow tourists to experience happiness but also allow tourists to immerse themselves in its rich beauty, science, philosophy, and culture (South Pacific Applied Geoscience Commission-SOPAC 2005).
Natural features

As the object of the ecotourism system, the rule of temporal and spatial distribution of ecotourism resources.

Extensiveness Ecotourism resources are widely distributed. As a geographical space, it is not only mountainous areas with a small population but also ecotourism resources in the suburbs of cities (Tomás et al. 2012).

Regionality It is impossible for ecotourism resources to find two similar places in nature.

Seasonality Seasonality means that from the point of view of time, the natural landscape will also change within a day, sunrise and sunset, etc.; there will be ecological landscapes that are important for sightseeing; and they are natural ecological landscapes that people enjoy (Tomás et al. 2007).

Timeliness Different historical backgrounds, different tourist objects, and different social backgrounds. Therefore, the characteristic of the ecological age is economic changes (Torabi et al. 2011).

Social characteristics

The infinity of spiritual value The so-called infinite spiritual value refers to the penetration of tangible eco-tourism resources, enabling people to create and imagine space or leave intangible spiritual value. Compared with the space limitations of tangible eco-tourism resource objects, the space for creation and imagination is unlimited (Walle et al. 2000).

National characteristics The characteristic landscape of an area where people and nature live in harmony under the cultural background of different nationalities. Under the regional cultural background, after long-term evolution, the combination of man and nature has formed a unique national landscape (Waltham 2009) (Wyllie and Mah 2004).

Economic characteristics

Immovability Refers to a completely immovable space. The regional and national characteristics of ecotourism resources determine that they can only exist in a specific natural environment and cannot be freely moved.

Renewability Refers to the possibility of regeneration of biological components in the ecological environment of ecological resources, which determines that they can form new ecosystem characteristics under the ecological law (Xu 2006) (Yan 2011).

Diversity of market demand Every tourist has different needs for the tourism market.

Paid We say that ecological resources exist as a part of the earth-scale ecosystem, play their role, and bring tangible or intangible benefits to mankind. However, as a kind of ecotourism resource, if it enters the category of eco-tourism, in order to reflect its value in the process of development and utilization, it is necessary to adopt appropriate evaluation methods (Yang 2007).

The composition of ecotourism

According to the above definition of ecotourism, travel agencies, transportation companies, accommodation facilities, catering companies, ecotourism resort companies, or institutions directly meet the needs of eco-tourism, and companies that help complete the eco-tourism experience are all within the scope of eco-tourism. Different expressions and names can be added according to the type of actual business (Yilmaz et al. 2012). The interrelationship of these businesses is shown in Fig 2.

Ecotourism is composed of a series of professional management organizations and non-professional management organizations, which exist in transportation and tourist attractions (see Fig 3). Under this framework, eco-tourism can be traveled as a formal tour group and FIT (free independent travel). Many operators have two types of eco-tourism elements. To illustrate, they are classified into two categories: “professional” and “non-professional” (Yilmaz et al. 2012). Similarly, eco-tourism is also distinguished by “formal tour group” and “FIT tour group.”

Materials and methods

Data source and preprocessing

Spectral data acquisition of airborne hyperspectral image sample points

After the Gaiasky-Mini hyperspectral imaging system obtains the hyperspectral image of the survey area, the corresponding spectral data of the soil sample is extracted from ENVI5.3 after black and white frame correction, radiation calibration and geometric correction, and abnormal spectral curve (Zaruba and Mencl 1976) Table 1.

ASD spectrum data and GS spectrum data preprocessing

Data preprocessing ViewSpecPro is used to preview the spectral data of all samples and exclude abnormal spectral curves.
Since the FieldSpec4 spectrometer has three detection elements, the mismatch of the junction of the detection elements will affect the reception of the spectral signal, and the spectral curve at 1000 and 1800 nm will suddenly change. Use ViewSpecPro’s spline correction tool to perform breakpoint correction, and export all sample data as TXT data. Due to the influence of the objective environment in the spectrum collection process, certain errors will inevitably occur. In the 350–399nm and 2400–2500nm spectral bands, the noise is more obvious, so the spectral data of these low-frequency bands will be deleted. The Savitzky-Golay (SG) method is used to smooth the spectrum. This helps to eliminate noise caused by background, angle, lighting, and other factors in the spectrum acquisition process.

**Spectral transformation**

1. **Continuum removal**

Kate and Clak originally proposed the concept of continuum removal (also known as envelope removal). This is defined as the connection of each point of the “peak” value of the reflection projection or absorption according to the wavelength change and the external angle > 180. The absorption characteristics of the actual spectrum can be emphasized, such as frequency band position, width, depth, asymmetry, and normalized reflection value. In other words, the value range is 0 to 1, so the characteristic value is compared with other spectral curves for easy screening Fig. 4.

2. **Differential transformation S2**

In the spectrogram, the first differential reflectance (FDR) conversion effectively reflects the fluctuating trend of the original spectral reflectance. “Valley” represents the minimum gradient, and “peak” represents the maximum gradient when the spectrum rises, which mainly reflects the rise and fall of the slope of the result of a differential transformation. When used, the appropriate difference magnitude is the key to the differential conversion result. If the magnitude of the difference is too large, most of the detailed spectra will be lost due to smooth migration. If the magnitude of the difference is too small, the noise will increase, which will affect the quality of the subsequent analysis model. For this method, please refer to Eqs. 1 and 2.

\[
E^\prime(\lambda_i) = \frac{dE(\lambda_i)}{d\lambda} = \frac{E(\lambda_{i+1}) - E(\lambda_{i-1})}{2\Delta\lambda}
\]

\[
E^{\prime\prime}(\lambda_i) = \frac{d^2E(\lambda_i)}{d\lambda^2} = \frac{E^\prime(\lambda_{i+1}) - E^\prime(\lambda_{i-1})}{2\Delta\lambda} = \frac{E(\lambda_{i+2}) - 2E(\lambda_i) + E(\lambda_{i-2})}{4(\Delta\lambda)^2}
\]

Here, I is the band sequence; the \(\Delta\lambda\) value is the wavelength difference that is interrogated by spectral sampling for all decisions Fig. 5.
Particle swarm optimization neural network model design and accuracy evaluation method

It is assumed that the tested $t$ samples are inferred by the particle swarm optimization neural network model, and the estimated value is obtained. At this time, the remaining standard deviation of the estimated value is

$$\sigma = \sqrt{\frac{1}{t-1} \sum_{i=1}^{t} \left[\hat{y}_i - \hat{y}(i)\right]^2}$$  \hspace{2cm} (3)

Here $\hat{y}(i)$ is the estimated value of the $i$-th sample to be tested. $y(i)$ is the measured value of the $i$-th sample to be tested.

Next, the gray-scale estimation interval of the test sample is as follows.

$$\hat{y}_i \in [\hat{y}(i) - \beta \sigma, \hat{y}(i) + \beta \sigma]$$  \hspace{2cm} (4)

In the formula, $\beta$ represents any positive real number, and its value range is $[1,3]$.

---

**Table 1. Description of the acquisition of spectral data**

| Project      | Types of          | Number of samples of each type | Number of spectra |
|--------------|-------------------|--------------------------------|------------------|
| GS spectrum  | Soil              | 50                             | 250              |
|              | Eggplant fruit    | 25                             | 312              |
|              | Eggplant leaves   | 25                             | 469              |
|              | Pepper fruit      | 19                             | 282              |
|              | Pepper leaves     | 19                             | 463              |
|              | Total             | 2042                           |                  |

---
Use the obtained gray-scale interval to screen the modeling samples, and test 70 modeling samples to confirm whether they meet the gray-scale interval. Keep the gray interval samples, and exclude the samples outside the interval range. At the same time, the number of samples on both sides of the midpoint of the interval may be inconsistent, which may cause deviations in the results. At this time, the side with a small number of samples will be kept, and the side with a large number of samples will be further screened. The screening method is as follows. First, divide the sample into the number of intervals on both sides, and determine which side of the sample size is smaller. Assuming that the interval to the left of the sample number is smaller, the sample size is as follows.

\[
\delta = \frac{1}{n} \sum_{i=1}^{n} \left( \frac{\tilde{y}_i - y_i}{y_i} \right) \times 100\%
\]

\[
R^2 = \frac{\sum_{i=1}^{n} \left( \tilde{y}_i - \tilde{y} \right)^2}{\sum_{i=1}^{n} (y_i - \tilde{y})^2}
\]

Here, N is the number of samples; \( \tilde{y} \) is the average of the measured values.

Software platform design

In this paper, Origin 9.1 is used for differential calculation, and software such as ViewSPECT andSpecsight is used for spectral processing.

Results

Detection and spectral analysis of heavy metal content in mountain soil

Statistical characteristics of soil heavy metal content

As shown in Table 2, the Cd element in the survey area is higher than the average value of the soil environmental quality. The results show that the soil ecological environment in the survey area is relatively safe and there is no basic soil heavy metal pollution. The content of Pb and Cr in the soil in the surveyed area is relatively high, with an average of 20.25 mg kg\(^{-1}\) and 40.48 mg kg\(^{-1}\), respectively, but the Hg content is relatively low, with an average of only 0.05 mg kg\(^{-1}\).

In soil science, the volatility of soil properties is evaluated according to the coefficient of variation. The coefficients of variation of 0–15%, 16–35%, and more than 35% are small, medium, and high, respectively. The coefficient of variation of Pb and Cr is in the range of 16–35%, showing a moderate variation. The soil contains a lot of metal elements, and it turns out that heavy metals are evenly distributed in the soil.
Analysis of soil spectral characteristics

The prerequisite for the application of hyperspectral technology to soil heavy metal pollution monitoring is the spectral response mechanism of soil heavy metals. To find the objective law of this mechanism, the impact of the objective environment is small, and basic experiments must be carried out under the condition of high signal-to-noise ratio. As shown in Fig 6, with the same soil properties, the spectral curves of the ASD spectral data obtained from the air-dried soil samples in the laboratory are relatively consistent, and the relevant spectral characteristics are more obvious. However, the hyperspectral data obtained on the spot is mainly affected by the outdoor measurement environment such as sunlight, water vapor, carbon dioxide, wind, and people, with large fluctuations and weak regularity (refer to Fig 7).

ASD spectrum As shown in Fig 6, in the survey area, the spectrum of the soil sample obtained by the ASD spectrometer is relatively stable, and the shape of the spectrum curve is basically the same. That is to say, in the range of 800–1200 nm, the change in tilt will also become larger. After 1200 nm, the trend becomes flat, and two typical water absorption peaks appear at 1400 and 1900 nm. Generally speaking, the reflectivity of the near-infrared band (NIR) is higher than that of the visible band (VIS). Since the spectral data is obtained indoors, the positions of the characteristic bands of the samples are basically the same, but the sample points are different, the content of the soil composition is different, and the reflectance of the characteristic bands of each sample point is different. As shown in Fig 8, the higher the soil organic content, the lower the spectral reflectance.

GS spectrum Because this data is acquired for outdoor spectral data, it is greatly affected by the environment. As shown in Figure 7, 7400–900 nm, in the general reflectance range of a gradual upward trend, compared with the ASD spectrum, there is a significant absorption peak near 950 nm. Because it is an area affected by iron, organic matter, and water content, it may be affected by soil properties. However, due to the complexity of the soil as a whole, it is unscientific to judge from the influencing factors due to various factors such as the base material, iron oxide, the mechanical composition of the soil, and organic matter.

### Table 2: Statistics of soil heavy metal content

| Heavy metal | Minimum (mg·kg⁻¹) | Max (mg·kg⁻¹) | Average Value (mg·kg⁻¹) | Standard Deviation | Skewness | Kurtosis | Coefficient of variation (%) | National first-level standard (mg·kg⁻¹) | Environmental quality evaluation standard of edible agricultural products producing area (mg·kg⁻¹) |
|-------------|--------------------|---------------|-------------------------|--------------------|----------|----------|-----------------------------|--------------------------------|--------------------------------------------------|
| As          | 1.39               | 2.24          | 1.74                    | 0.22               | 0.31     | -0.98    | 12.17                       | 15.01                          | 30.01                                     |
| Pb          | 16.11              | 31.71         | 20.25                   | 3.11               | 1.79     | 3.89     | 15.42                       | 35.00                          | 50.00                                     |
| Cr          | 27.51              | 74.01         | 40.49                   | 9.05               | 1.86     | 3.95     | 22.35                       | 90.00                          | 150.01                                    |
| Cd          | 0.23               | 0.42          | 0.34                    | 0.05               | -0.11    | -0.01    | 12.19                       | 0.21                           | 0.30                                      |
| Hg          | 0.05               | 0.07          | 0.06                    | 0.01               | 0.83     | 1.14     | 6.71                        | 0.16                           | 0.25                                      |

Fig. 6 ASD raw spectral reflectance

Fig. 7 GaiaSky-mini original spectral reflectance
Evaluation results of mountain soil organic matter based on machine learning

BP neural network estimation results

From the comprehensive Table 3 and Fig 9, the BPNN model predicts the results of 10 samples with a relative error prediction value of less than 10%, indicating that the stability of the BPNN model is also improved compared with the multi-linear regression model. The non-linear model is effective in predicting the content of soil organic matter.

SVM estimation results

It can be seen from Table 4 and Fig 10 that, compared with the multi-linear regression model and the BPNN model, in the prediction results of the SVM model, not only the accuracy is greatly improved, but the stability of the model is also improved.

PSO-BP neural network estimation results

In this study, the PSO algorithm parameters are set, as shown in Table 5.

Table 3  BP neural network estimation results

| Sample number | Measured value (g/kg) | Predicted value (g/kg) | Absolute value of relative error (%) | Coefficient of determination |
|---------------|-----------------------|------------------------|-------------------------------------|-----------------------------|
| 60            | 16.486                | 14.693                 | 10.873                              |                             |
| 82            | 18.342                | 19.341                 | 5.447                               |                             |
| 23            | 18.813                | 22.856                 | 2.152                               |                             |
| 51            | 19.444                | 18.825                 | 3.171                               |                             |
| 31            | 19.422                | 18.402                 | 5.253                               |                             |
| 22            | 20.356                | 23.291                 | 14.411                              |                             |
| 12            | 20.008                | 23.234                 | 16.136                              |                             |
| 8             | 23.858                | 22.916                 | 3.947                               |                             |
| 43            | 16.537                | 15.972                 | 3.427                               |                             |
| 73            | 17.237                | 15.905                 | 7.731                               |                             |
| 34            | 15.722                | 16.206                 | 3.091                               |                             |
| 89            | 18.354                | 21.248                 | 15.767                              |                             |
| 30            | 21.751                | 22.768                 | 4.676                               |                             |
| 44            | 16.525                | 15.267                 | 7.615                               |                             |
| Average relative error |                      |                        | 8.790                               |                             |
It can be seen from Table 5 and Fig. 11 that in the prediction results of the SVM model, the accuracy of some samples decreased slightly, among which sample No. 8 was the most obvious, which dropped from 3.949 to 11.07%. However, this is only an isolated case.

### Inversion of soil heavy metal content based on organic matter content

#### Division of modeling set and verification set

The soil organic matter (SOM) content is determined by the potassium chromate volume method and the external heating method. The 50 soil samples are classified according to the organic content from small to large. Every two samples are selected for model testing, and the remaining samples are used for modeling (refer to Table 6).

It can be seen from Fig 12 and Fig 13 that after the differential conversion, the correlation coefficients between each other have been improved, as shown in Table 7.

#### Establishment of Partial Least Squares Regression Model

The original spectral estimation model of soil Cd content

According to the correlation coefficient between the modeling group R of the GS spectrum and the modeling group R of the ASD spectrum and the soil Cd content, a sensitive band was selected for the establishment of the model Fig. 14.

The first-order differential estimation model of soil Cd content

According to the correlation coefficient between FDR and soil Cd content of GS spectral modeling group FDR and ASD spectral modeling group, the sensitive wave band was selected for establishing the model. The results showed that the FDR model of GS spectrum was better Fig. 15.

The second-order differential estimation model of soil Cd content

According to the correlation coefficient between GS spectral modeling set SDR and ASD spectral modeling set SDR and soil Cd content, a sensitive band was selected for establishing the model. The best SDR bands of GS spectrum are 403, 513, 790, and 818 nm, while ASD spectrum has the ability to distinguish high and low values of Cd.
Discussion

Environmental impact of ecotourism

Inevitable problems brought about by eco-tourism

Although eco-tourism will bring economic income to the region, it will cause adverse effects on the environment if it is unreasonably developed. For this reason, in this area, in order to better promote tourism activities, tourists must be restricted. Due to tourism seasonality, some tourism activities, the number of tourists, and the intensity of development are difficult to control, which exceeds the environmental protection capacity of the nature reserve. Scientific and reasonable management of eco-tourism projects and prevention of tourism safety accidents are issues that should be resolved as soon as possible in nature reserves.

Operational issues of ecotourism

At present, the environmental damage and pollution problems in nature reserves in China are very significant. The main reasons are as follows: First, with the rise of eco-tourism, tourism operators across the country ignore the protection requirements and plans of nature reserves and blindly build various tourist facilities. Many of them violated the plan’s goals. In addition, because many eco-tourism projects in nature reserves are urgent and there are no detailed eco-tourism plans, most of the construction projects are contrary to the original intention of eco-tourism, and there is no environmental impact assessment. A large number of artificial facilities and the artificial landscape directly causes serious damage to the natural landscape. In the end, the construction of transportation routes and service facilities will inevitably require the construction of several sightseeing projects, which will affect ecological indicators. At the same time, the development of eco-tourism in nature reserves, such as the large-scale construction of hotels, restaurants, other service facilities and other recreational facilities, and the artificial reconstruction of scenic spots, will inevitably destroy the surrounding natural environment and vegetation and put roads on both sides. The planting of vegetation in scenic spots will not only destroy organisms but also cause serious soil erosion. A large number of tourists flock to and gather in scenic spots, trample on, damage, and destroy soil and vegetation, and soil erosion increases, thereby affecting vegetation growth and destroying the environment and natural scenic spots. On the other hand, this is mainly related to the compatibility of the tourism service landscape in the nature reserve such as the

---

**Table 5** PSO-BPNN model estimation results

| Sample number | Measured value (g/kg) | Predicted value (g/kg) | Relative error absolute value (%) | Decisive factor |
|---------------|-----------------------|------------------------|-----------------------------------|----------------|
| 60            | 16.486                | 17.635                 | 6.957                             |                |
| 82            | 18.342                | 18.639                 | 1.618                             |                |
| 23            | 18.813                | 19.137                 | 1.743                             |                |
| 51            | 19.446                | 18.774                 | 3.462                             |                |
| 31            | 19.420                | 18.388                 | 5.315                             |                |
| 22            | 20.356                | 19.542                 | 3.996                             |                |
| 12            | 20.008                | 19.806                 | 1.008                             |                |
| 8             | 23.858                | 21.234                 | 11.006                            |                |
| 43            | 16.537                | 16.955                 | 2.517                             |                |
| 73            | 17.235                | 18.066                 | 4.808                             |                |
| 34            | 15.720                | 16.234                 | 3.29                              |                |
| 89            | 18.356                | 19.354                 | 5.45                              |                |
| 30            | 21.752                | 19.895                 | 3.3                               |                |
| 44            | 16.528                | 16.344                 | 1.4                               |                |
| Average relative error |                    |                        | 4.344                             |                |

At present, the environmental damage and pollution problems in nature reserves in China are very significant. The main reasons are as follows: First, with the rise of eco-tourism, tourism operators across the country ignore the protection requirements and plans of nature reserves and blindly build various tourist facilities. Many of them violated the plan’s goals. In addition, because many eco-tourism projects in nature reserves are urgent and there are no detailed eco-tourism plans, most of the construction projects are contrary to the original intention of eco-tourism, and there is no environmental impact assessment. A large number of artificial facilities and the artificial landscape directly causes serious damage to the natural landscape. In the end, the construction of transportation routes and service facilities will inevitably require the construction of several sightseeing projects, which will affect ecological indicators. At the same time, the development of eco-tourism in nature reserves, such as the large-scale construction of hotels, restaurants, other service facilities and other recreational facilities, and the artificial reconstruction of scenic spots, will inevitably destroy the surrounding natural environment and vegetation and put roads on both sides. The planting of vegetation in scenic spots will not only destroy organisms but also cause serious soil erosion. A large number of tourists flock to and gather in scenic spots, trample on, damage, and destroy soil and vegetation, and soil erosion increases, thereby affecting vegetation growth and destroying the environment and natural scenic spots. On the other hand, this is mainly related to the compatibility of the tourism service landscape in the nature reserve such as the

---

**Fig. 11** PSO-BPNN model prediction results
shape, layout, color, and texture of the building. In order to implement eco-tourism in the nature reserve, it is necessary to adjust the service facilities and the reserve as a whole in the above four aspects.

The key to controlling the impact of ecotourism

Many problems in the development of ecotourism in China's nature reserves are not the adverse effects of ecotourism, but the result of violating the basic principles of ecotourism. First of all, due to the destruction of vegetation and disorderly construction of hotels, there is a lack of supervision and management of ecotourism construction in nature reserves. Secondly, environmental pollution and the deterioration of resources in nature reserves are mainly due to improper management of tourist capacity. In addition, the important feature of ecotourism is to participate in regional society and share benefits.

Construction and management of eco-tourism scenic spots and scenic spots

Early-stage management of the construction of eco-tourism scenic spots in nature reserves

Preliminary work First of all, it needs to be studied and planned. The feasibility study of ecotourism plan is mainly composed of eco-tourism. The ecological plan belongs to a special area. However, the ecotourist plan formulated separately will become the object of the general plan and be submitted to the administrative department of the nature reserve for approval.

Project approval Under normal circumstances, after completing the preparations for eco-tourism development, the nature reserve management agency will summarize the project proposals and submit them to the competent administrative department with the authority of review and approval for review and approval. After the project proposal is approved, the management agency of the reserve and development investors will also organize the preparation of the project feasibility report and submit it for review and approval. The feasibility report mainly includes the site selection and scope of ecotourism development, the resource status of development and utilisation, the scale of development and utilization, tourism model, tourism ability analysis, environmental impact analysis and countermeasures, investment estimation, and profit analysis.

Design and construction The construction of eco-tourism scenic spots can only enter the design and construction stage after the project is approved and the feasibility report is approved. The construction of tourist facilities should fully reflect the principle of coordination with the natural landscape and maintain the background conditions of the nature reserve. Scenic roads should be repaired in line with the natural topography, original roads, and main pedestrian roads. The architectural style of tourism support service facilities reflects the characteristics of the region and the nation. In order to reduce the pressure on the protection of regional resources and the environment, it must be deployed around the protected area as much as possible.

Operation and management Operational management refers to the management after the implementation of eco-tourism development projects. For management agencies and development operators of nature reserves, the focus is on the

| Table 6 | Statistical characteristics of soil organic matter content |
|---------|-----------------|
| Sample type | Number of samples | Minimum | Max | Mean | Standard deviation | Coefficient of Variation |
| Overall sample | 50 | 31.20 | 61.10 | 44.70 | 8.16 | 18.23 |
| Modeling sample | 34 | 31.40 | 61.00 | 44.66 | 8.73 | 19.54 |
| Validation sample | 16 | 35.50 | 55.70 | 45.07 | 6.81 | 15.12 |

| Table 7 | The maximum values and corresponding bands of correlation coefficients between different spectra and soil organic matter |
|---------|-----------------|
| Project | Spectral transformation | Number of bands | Maximum correlation band | Correlation coefficient |
| GS | R | 90 | 915 | 0.367 |
| FDR | 40 | 710 | 0.621 |
| SDR | 57 | 683 | 0.578 |
| ASD | R | 70 | 1010 | 0.625 |
| FDR | 179 | 694 | 0.663 |
| SDR | 130 | 994 | 0.705 |
operation and management of tourism and service facilities, tourism management, and environmental protection facilities. On the other hand, the management department of the nature reserve is mainly responsible for the management and development of ecotourism in the nature reserve, the implementation of environmental protection countermeasures, and the supervision and management of the operation of environmental protection facilities.

Environmental management of ecotourism construction in nature reserves

Environmental management at the project approval stage

The environmental management of the project establishment stage includes the environmental management filing of the project proposal and the environmental impact assessment after the project is approved. Opinions on environmental management records (preliminary environmental review) are one of the important foundations for the approval of ecotourism projects by the nature reserve management department. On the one hand, the administrative authority of the nature reserve applies to the administrative department in charge of environmental protection to establish an eco-tourism project, and on the other hand, it submits an eco-tourism project proposal to the administrative department in charge of environmental protection. The management department of the nature reserve shall not approve the project until the environmental protection department conducts an environmental impact assessment of the project and signs the agreement opinions.

Environmental management during construction period

Environmental management during the development and construction of ecotourism mainly includes the implementation of ecological protection and restoration technical measures, the
Construction and management of pollution prevention facilities, ecological protection and restoration technical countermeasures, and the acceptance of environmental protection facilities. The daily environmental management during the construction period is mainly in charge of the management agency of the nature reserve and the management department under its jurisdiction. The environmental protection management department at the location of the protected area is mainly responsible for inspection and environmental protection, and the local management department for environmental protection is responsible for the ecological protection, restoration, and management of environmental protection facilities.

**Strategies to strengthen eco-environmental management in tourist areas**

**Reasonably delimit the functional areas within the nature reserve**

In order to avoid damage to the protected objects due to tourism activities, it is necessary to optimize the utilization of tourism resources. It is necessary to divide nature reserves into functional areas to develop eco-tourism. The core area is a heavily protected area. All kinds of resource development activities should be strictly prohibited and used only for observation and research. The scattered entertainment area is the object of several scattered tourists. Only foot or simple transportation can enter the venue, and the number of tourists is strictly limited. With the increase in the content of nature protection and the division of functional areas, the number of tourists is decreasing, and the attraction to tourists is also increasing.

**Strengthen legislation, improve the legal system and management system**

At present, China's laws and regulations on nature reserves are not perfect. All relevant domestic legislative departments must improve laws as soon as possible and establish a legal system suitable for the protection and development of nature reserves with Chinese characteristics. At the same time, although there are legal provisions on the protection of nature reserves, many departments have taken independent actions, and blind exploitation in violation of legal provisions has been repeatedly prohibited. The main reason for this problem is the slowness of law enforcement. Many government departments and legal systems allow the above phenomenon to develop freely from current interests or their own considerations, causing many irreversible losses. From this point of view, the country must learn lessons from the successful management of overseas nature reserves in order to promote the improvement of management quality.

**Carry out eco-tourism education and raise public awareness of environmental protection**

First of all, the person in charge of ecotourism development and management should educate tourists to recognize current development trends, consciously apply ecological principles to tourism development and management, introduce actual ecotourism products, and promote the coordinated development of ecotourism development. Second, tourists must consciously abide by tourism rules and regulations, raise awareness of ecology and environmental sustainability, consciously use ecological principles to guide tourism actions, and strengthen environmental protection education for tourists.

**Actively encourage local residents to participate in eco-tourism**

Through the active participation of local residents, the characteristics and traditions of the region can be used more effectively, and the charm of eco-tourism can be enhanced. At the same time, the development of eco-tourism promotes the development of other sectors; increases employment opportunities such as tour guides, safety, health, and handicrafts; increases residents’ income; establishes a close relationship between them and eco-tourism; and enables them to consciously participate in nature conservation. Protection of the area.

**Conclusion**

For testing the composition of mountain soil, the most direct impact of heavy metal pollution in the soil is that plants that draw nutrients from the soil are also contaminated. GS spectroscopy can be used to monitor the content of heavy metals in wetland soil. According to the discrete principle and the principle of maximum correlation, the characteristic factors used to estimate organic matter are selected, the gray interval is introduced, and the particle swarm optimization neural network model based on the gray interval is established to provide help for soil detection. Moreover, eco-tourism can be defined from various viewpoints. From the perspective of dynamic development, ecotourism is an activity that transforms from an unsustainable natural resource management model to a more environmentally friendly tourism. Eco-tourism in nature reserves is the key to strengthening management of ecotourists, community management, scenic areas and scenic areas management, and conservation area eco-tourism benefits management. It is a scientific, complete, and effective environmental monitoring system and a solid foundation for effective management of the ecosystem.
Declarations

Conflict of interest  The authors declare that they have no competing interests.

References

Roslan R, Omar RC, Nor I, Baharuddin Z, Wahab WA (2019) Application of Slope Mass Rating System In: Slope Stability Class Evaluation. (1), 3645-3649

Rowell DJ (2010) Aggregate resources inventory of the county of Hastings, southern Ontario, Ontario Geological Survey. Aggregate Resources Inventory Paper 186. 86p

Sadat-noori SM, Ebrahimi K, Liaghat AM (2013) Groundwater quality assessment using the water quality index and GIS in Saveh-Nobaran aquifer, Iran. Environ Earth Sci 71(9):1–17

Shang J, West LJ, Hencher SR, Zhao Z (2018) Geological discontinuity persistence: implications and quantification. Eng Geol 241(2017): 41–54

Sharma S, Raguvanshi TK, Anbalagan R (1995) Plane failure analysis of rock slopes: Technical Note. Geotech Geol Eng 13:105–111

Singh B, Goel RK (2011) Engineering rock mass classification: tunneling, foundations, and landslides. Elsevier Inc, Cambridge, p 382

Smith MR (ed) (1999) Stone: Building stone, rock fill and armourstone in construction, geological society, London. Engineering Geology Special Publication No. 16, pp 498

South Pacific Applied Geoscience Commission-SOPAC (2005) Identification of onshore aggregate quarry sites & prospects for quarry development, Pohnpei Island, federated states of micronesia. SOPAC Technical Report 382, pp 48

Tomás R, Delgado J, Serón JB (2007) Modification of slope mass rating (SMR) by continuous functions. Int J Rock Mech Min Sci 44(7): 1062–1069

Tomás R, Cuenca A, Cano M (2012) A graphical approach for slope mass rating (SMR). Eng Geol 124:67–76

Torabi SR, Ataei M, Javanshir M (2011) Application of Schmidt rebound number for estimating rock strength under specific geological conditions. J Min Environ 1(2):1–8

Walle H, Zewde S, Heddal T (2000) Building stone of central and southern Ethiopia: deposits and resource potential. Notat Geologiske Undersøkelser Bulletin 436, N-7491 Trondheim, Norway. 45–157

Walther AM (2009) Foundations of engineering geology, 1st edn. Spon Press, Taylor & Francis, London and New York, p 105

Wyllie DC, Mah CW (2004) Rock slope engineering: civil and mining, 4th edn, London 10:456

Xu GX (2006) Earthquake engineering. Seismological Press, Beijing

Yan ZX (2011) Study on resonance characteristics and natural frequency of slope under bidirectional seismic action. Hydrogeol Eng Geol 38(2):46–51

Yang J (2007) The Long-term stability reliability of the earth slope by seismic action. Fujian Construct Sci Technol 2:8–9, 19

Yilmaz I, Marschalko M, Yildirim A, Dereli E, Bednarik M (2012) GIS-based kinematic slope instability and slope mass rating (SMR) maps: application to railway route in Sivas (Turkey). Bull Eng Geol Environ 71:351–357

Zang ZY (1981) Principles of engineering geological analysis. Geological Publishing House, Beijing

Zaruba Q, Mencl V (1976) Engineering geology. Elsevier Scientific Publishing Company, Amsterdam, p 498