Research on Sustainable Development of Tourism Resources in Abandoned Gemstone Mining Areas with Big Data Technology: A Case Study of Turquoise Mining in Yungui Temple Area

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Abstract

This paper explores the sustainable development of tourism resources in abandoned mining areas by taking the development of tourism resources in the turquoise mining area of Yungui Temple as an example. Through the end management, resource utilization, and reuse model of the abandoned turquoise ore, the material flow of tourism guiding reconstruction in the mining area is constructed. On this basis, the ecological benefits of tourism development in the Yungaisi mining area were designed, and the degree of ecological damage in the mining area was evaluated by combining data mining technology. The results show that through the development of tourism resources, the eastern slope of the Yungaisi turquoise mine increased by about 8450 m² of seedling planting, the greening area of the abandoned land increased by about 16008.82 m², and the greening of the western waste mine pile increased by about 18359.25 m², which realized the sustainable development of the Yungaisi scenic area. This paper's research examines the sustainable development of tourism resources in abandoned gemstone mining areas, which has a guiding significance in practice.

Keywords: Turquoise mining; Eco-efficiency; Material flow; Data mining; Resource utilization.
AMS 2010 codes: 97P24
1 Introduction

In recent years, with increasing attention to environmental protection and sustainable development, the reuse of abandoned mining areas and the development of tourism resources have become hot spots for research [1-2]. However, the ecological environment of abandoned mining areas has been seriously damaged, and how to achieve sustainable development of tourism resources in abandoned mining areas to protect the ecological environment has become an urgent problem [3-5].

In such a context, the development of big data technology provides new ideas and means for reusing abandoned mining areas and developing tourism resources [6]. Big data technology can provide in-depth analysis and assessment of the ecological environment, geological formations and tourism resources of mining areas and provide scientific basis and decision support for developing tourism resources in abandoned mining areas [7-8]. At the same time, big data technology can also evaluate and analyze the development benefits of tourism resources and provide scientific methods and means for the sustainable development of tourism resources in abandoned mining areas [9].

The use of big data technology can aid in the development of tourism resources in abandoned mining areas. The literature [10] presented the value and potential of mining tourism in terms of economic, environmental and social aspects and then proposed three strategies for tourism development, namely cultural, natural and adventure types. The literature [11] analyzed the potential and sustainability of the quarry as a tourism resource and suggested aspects to be considered in developing the stone quarry as a tourism resource, including resource conservation, underground space utilization, and visitor safety. The presentation also discusses the application of flexible tourism models and the utilization of local community resources to ensure the sustainability of quarry tourism. The literature [12] studied the attractiveness of the old coal mining town of Sowalento, Indonesia, as a tourist destination, and he found that Sowalento’s cultural and historical heritage, natural resources, and coal culture have a strong appeal to tourists.

Industrial tourism falls under the category of industrial tourism, which combines industry and tourism [13]. The literature [14] examined the issue of developing entrepreneurial businesses in post-industrial tourism attractions, using the Industrial Heritage Trail as an example. The challenges faced by entrepreneurs in developing tourism businesses in industrial heritage trails are discussed, including preserving historic buildings, improving visitors’ understanding of industrial history, and developing innovative tourism products. The literature [15] examines the development path of the Petrila mining region in terms of future industrial heritage tourism, and he argues that industrial heritage tourism as a separate market and development direction can effectively contribute to the economic and social development of the Petrila region. The literature [16] discusses the environmental problems caused by the decommissioning of coal mines in India, which include land degradation, droughts, floods, and soil erosion. He proposed using ecological restoration techniques to address these problems and emphasized the integration of Sustainable Development Goals (SDGs) with tourism to achieve sustainable development.

This paper focuses on the application of big data technology in the sustainable development of tourism resources in abandoned gemstone mining areas, taking turquoise mining in the Yungaisi area as an example to explore the balanced relationship between the development of tourism resources in abandoned mining areas and the protection of the ecological environment. Different modes of reuse of abandoned turquoise ore in Yungaisi Temple are explored, including end-of-pipe treatment, resource utilization, and reuse modes. The reconstruction process for the tour guide of the Yungai Temple mining area involves constructing the direction of the material flow. In terms of ecological benefits, the research design of restoring species diversity, landscape aesthetic quality, reducing heavy metal pollution in soil, water conservation benefits and soil and water conservation benefits are
explored. Specific cases are used to analyze and evaluate the economic benefits of tourism resource development in the Yungaisi turquoise mining area.

2 Tourism resources development of Yungaisi turquoise mining area

2.1 Reuse of waste turquoise ore at Yunkai Temple

Reuse is the process of reusing ore waste in whole or in part as a new product after direct or physical processing. The process of ore waste reuse goes through selection, testing, processing, etc., and is used secondarily in constructing mine parks. The process of reuse inevitably causes secondary pollution to the environment. The first topic of discussion in this paper is the direct reuse of green pine ore waste in the construction of Yungaisi Mine Park.

The reuse was proposed at different times and stages, and its development has gone through three stages, as shown in Figure 1. Eventually, a holistic and comprehensive constraint system is formed in mining, discarding and reusing ore waste.

![Figure 1. Three stages of reuse development](image1)

2.1.1 End-use governance model

The material flow of the reuse of green pine ore waste in the Yungaisi area under the end-use treatment model shows a one-way linear material flow of “resource-product-pollution,” as shown in Figure 2. The stone resources in the Yungaisi area are extracted to a great extent in this model, and the ore waste is treated without reasonable reuse. It is processed into non-polluting and non-hazardous substances and disposed of in landfills and mountainous areas. The total amount of ore waste in nature will increase, and the demand for new resources will increase with reclaimed resources in the end management mode.

![Figure 2. Treatment of ore waste in end-of-pipe mode](image2)

2.1.2 Resource utilization model

Resource utilization makes the material flow in a feedback process, i.e., resource-product-renewable resource process, as shown in Figure 3. In this continuous cycle, it is crucial to use ore waste in a sustainable and maximum way, minimizing its impact on the natural environment as much as possible. The more waste is recycled into raw materials, which are then used to manufacture new products as needed. In the resource-based model, a series of reprocessing processes, such as crushing and hot pressing of the ore waste, are usually required, and the economic and environmental costs of reuse are added to the process.
2.1.3 Reuse mode

The utilization pattern of green pine ore waste in the Yungaisi area under reuse mode is resource-product-ore waste-product, as shown in Figure 4. There are two types of the reuse mode. One is process reuse, and the other is ecological reuse. Process reuse is to embed the ore waste in the material cycle of the product production process, not to dump it directly in nature as end-of-pipe treatment, and not to consume more energy in the reuse process of resource reuse. Ecological reuse involves using ecological methods to integrate ore waste into the natural ecological cycle, as in sewage filtration. Filtered impurity particles can also provide other microorganisms, plants, and animals with a medium of life and activity.

Both models make it possible to recycle the green pine ore waste from the Yunkaiji area by recycling it for multiple uses in mining and consumption, which can be used as a product function. In addition, the continuous use of this cycle prevents the generation of new energy consumption. The recycling model has advantages over emissions in terms of environmental protection because it minimizes the impact of ore waste accumulation on the environment. At the same time, compared with the new energy consumption generated in the process of ore waste transportation and processing products under the resource utilization mode, it is obvious that the advantage of the reuse mode is greater than that of the resource utilization mode.

2.2 Material flow of the process of reconstructing the tourism landscape of the Yungaisi mining area

The process of reconstructing the tourism landscape of the Yungaisi turquoise industrial mine waste site has gone through the process of boundary evolution from ecosystem scale, landscape scale, urban and regional scale, and the input, output and stock of system material flow are transformed into each other with the expansion of system boundary, and the transformation relationship among the three is shown in Figure 5.
1) Material flow in the ecological restoration stage of the turquoise mine abandoned area

The original material stock of the system in the abandoned area of Yungaisi turquoise mine is mainly vegetation, soil, water system, and its various pollutants, and the material flow input in the ecological restoration process is mainly for the environmental management of various substances. In this process, the change of material flow is mainly reflected in reducing pollutant stock in soil, water systems, and various environmental elements.

2) The material flow of the landscape reconstruction stage of the ecological restoration system of industrial and mining abandoned land.

In the landscape reconstruction stage of the ecological restoration system of industrial and mining waste sites, the material input of the system is mainly used for terrain remodeling, the transformation of old buildings and structures, the reuse of solid waste, and the construction of various landscape sites. In this process, the stock material of the industrial and mining abandoned land system does not change greatly, and the material input of the system mainly makes the external form, function and value of various kinds of stock material change, forming various landscape functional places.

3) Material flow in the coupling stage of industrial and mining wasteland landscape ecosystem and mining tourism system

The main material flow input of the system in the development stage of the coupling of industrial and mining abandoned land landscape ecosystem, and the mining tourism economic system includes the construction input of tourism resources development and tourism infrastructure. Through the integration and redevelopment of tourism landscape resources, the system material stock, such as underground space of abandoned mines, abandoned industrial and mining equipment, and mining cultural relics with monumental significance and heritage value, are transformed from hidden material flow to cultural heritage resources.
3 Benefit design for tourism development of Yungai Temple turquoise mining area

3.1 Case site selection

In this paper, the Yungaisi Turquoise National Mine Park in Shiyan City was selected as the research object of this paper based on the following reasons [17]:

1) The Yungaisi Turquoise National Mine Park area is about 6,000 square meters, divided into three parts: mining area, sightseeing area, and ecological area. Among them, the mine area is one of the main attractions of this scenic area, which is one of the famous turquoise mines in Hubei Province and is known as the treasure house of oriental turquoise.

2) The Yungui Temple Turquoise National Mining Area in Shiyan City, Hubei Province, is a turquoise mining site where the washing of ore causes extreme acidity in the soil. A large amount of waste gas, wastewater and slag produced during the mining process causes serious pollution to the environment, leading to the destruction of surface landscape, heavy metal pollution of soil, land degradation, groundwater pollution, and destruction of biodiversity, resulting in serious soil erosion and frequent geological disasters such as landslides and mudslides in the mining area. Its ecological and environmental problems are even worse; environmental restoration and treatment are more onerous and urgent, and the task of building a national mine park is more arduous, and its transformation has excellent significance for other mine parks.

3) In the 1970s, a large turquoise mine was discovered and proven in China at the Yungaisi Turquoise National Mine in Shiyan City, Hubei Province. It is also a world-class large-scale turquoise mine with the largest single mine reserves, the largest mining scale, the largest production, the lowest ore inclusion grade, the lowest single ore processing cost and the best economic efficiency in the world. Its mining relics represent China’s advanced technology and techniques, with profound cultural deposits, high scientific research value, aesthetic ornamental value and tourism economic value, so its construction of a national mine park is more typical. The Shiyan Yungaisi Turquoise National Mine Park is selected as the research object based on these three considerations.

3.2 Eco-efficiency study design

The evaluation indexes of ecological benefits include five indexes of restoring biodiversity, improving the aesthetic quality of the landscape, reducing heavy metal pollution of soil, conserving water and reducing soil erosion, as shown in Figure 6.
Figure 6. Eco-efficiency index of redeveloping mining derelict land into mine park

The benefits measures for each indicator are shown in Table 1.

<table>
<thead>
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<th>Indicator layer</th>
<th>Data</th>
<th>Calculation Method</th>
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<td>Restoration of biodiversity monitoring</td>
<td>Plant Diversity Index</td>
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<td></td>
<td>Improve aesthetic quality</td>
<td>Author’s self-photograph</td>
<td>Scenic Beauty Evaluation (SBE)</td>
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<td></td>
<td>Reduce heavy metal pollution in soil</td>
<td>Soil heavy metal pollution composite index</td>
<td>Nerome index method</td>
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<tr>
<td></td>
<td>Water conservation</td>
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<td></td>
<td>Reducing soil erosion</td>
<td>Slope loss per unit area</td>
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</tr>
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<td></td>
<td>Air purification benefits</td>
<td>Carbon sequestration and oxygen release</td>
<td>Carbon tax method, replacement cost method</td>
</tr>
<tr>
<td></td>
<td></td>
<td>value, SO\textsubscript{2} absorption value, dust deterrence value</td>
<td></td>
</tr>
</tbody>
</table>

3.2.1 Restoration of species diversity

Species diversity is the expression of biodiversity at the species level, including the meaning of both regional species diversity and ecological diversity. The diversity of the redeveloped mining wastelands into green space is discussed in this paper in terms of plant community diversity. In the study of plant community diversity, diversity indices are often used to describe changes in community diversity, and species diversity measurement indices mainly include four categories: species richness index, species diversity index, evenness index and ecological dominance index. Species richness index refers to the number of species in a certain area to express the abundance of organisms, and the commonly used richness indices are the Margalef richness index, the Gleason richness index and the Menhinick richness index. Species diversity indices combine species richness with species
multiplicity, and the Shannon-Wiener index and Simpson index are the most commonly used ones. Evenness indices include Pielou's and Alatalo's. The dominance index is an index indicating the ecological importance of species in the community. The equations for each index are as follows:

Margalef richness index:

\[ D_1 = \frac{(S - 1)}{\ln N} \]  

Menhinick Richness Index:

\[ D_2 = \frac{S}{N^{1/2}} \]  

Gleason Richness Index:

\[ D_3 = \frac{S}{\ln A} \]  

Shannon-Wiener Diversity Index:

\[ H' = -\sum_{i=1}^{S} P_i \ln P_i \]  

Simpson Index:

\[ H = 1 - \sum_{i=1}^{S} P_i^2 \]  

The Simpson dominance index has a minimum value of 0 and a maximum value of \( H_m = 1 - 1/S \).

Pielou evenness index:

\[ J = \frac{H'}{H_{\text{max}}} \]  

Alatalo Uniformity Index:

\[ E_o = \left\lfloor \left( \sum P_i^2 \right)^{-1} \right\rfloor / \left( \exp \left( -\sum P_i \ln P_i \right) - 1 \right) \]  

Eco-dominance index:

\[
\begin{align*}
D_o & = \sum P_i^2 \\
D_o & = \left[ \sum \left( N_i (N_i - 1) \right) / N(N - 1) \right]
\end{align*}
\]  

Where \( S \) is the number of species, \( N \) is the total number of individuals observed. \( N_i \) is the number of individuals of species \( i \) observed, \( P_i \) is the ratio of the number of individuals of species \( i \) to the total number of individuals in the community, \( H' \) is the Shannon-Wiener sameness index. \( H'_{\text{max}} \) is the maximum value of \( H' \), and \( A \) is the sample area.
The restoration community diversity involved in this paper refers to the Shannon-Wiener diversity index, and the difference in the Shannon-Wiener diversity index between mining waste sites and mine parks was used to measure the change of community diversity in the redevelopment of Yungaisi turquoise mining waste sites into green space.

3.2.2 Aesthetic quality of the landscape

Landscape aesthetic quality evaluation is mainly judged by the psychophysical method, which is divided into four categories: score value method, mean method, SBE method, and comparative judgment (LCJ) method. The SBE and LCJ methods are regarded as the most effective methods for evaluating landscape aesthetic quality, but the LCJ method is primarily used for small-scale landscape evaluation. Therefore, the landscape aesthetic quality evaluation in this paper uses the SBE method, which means that each landscape is judged according to a score of 0-5 using slides, and the SBE value of each type of landscape is calculated. Three major categories are used to categorize the types of landscapes in this study.

The landscape map of the former Yungaisi mining area is one of them.

The second map is the landscape map of Yungaisi Turquoise Mine Park.

The third area is the unmined and undisturbed landscape map surrounding the turquoise mining area.

The judging photos are the unmined landscape map around the mine park and the mine area, and the landscape map of the former abandoned mine area comes from the park management office. The judges consisted of graduate students from landscape architecture, ecology, and engineering greenery, experts, and graduate students in brown land reuse research.

3.2.3 Reduction of soil heavy metal pollution

The mining of the turquoise mine in Yungaisi has led to the excessive content of heavy metals such as PH, Cu, Pb, Zn, Cd, As, Mn, Cr and Ni in the soil, while much vegetation has an enrichment effect on the heavy metals in the soil, and can reduce the heavy metal content in the soil through vegetation restoration. The soil heavy metal indicators involved in this paper mainly include the changes of Cu, Pb, Zn, Mn, Cd, Cr and Ni contents. The calculation method uses the Nerome index method, which is currently the most common method for calculating soil pollution index in hand countries. The Nerome index method can reflect the degree of pollution of each pollutant in the soil comprehensively, and can calculate the single factor pollution index of different heavy metal pollutants, and then can calculate the comprehensive pollution index of heavy metals in a certain plot of land, the calculation formula is:

$$ P_i = \frac{C_i}{S_i} \quad (9) $$

$$ P = \sqrt{P_{ave}^2 + P_{max}^2} \quad (10) $$

Where, $P_i$ is the single factor pollution index of soil heavy metal element $i$, $C_i$ is the measured value of soil heavy metal element $i$, $S_i$ is the soil environmental quality standard value. $P$ is the integrated pollution index of the sampling sites, $P_{ave}$ is the average value of all single-factor
pollution indices of soil heavy metals, and $P_{\text{max}}$ is the maximum value of all single-factor pollution indices of soil heavy metals.

### 3.2.4 Water conservation benefits

To estimate the service value of terrestrial ecosystems in China, this paper proposes to use the global-scale ecosystem service value estimation method to make corrections and establish a table of ecosystem service value equivalent factors for China. The ecosystem service value equivalent factor is used as the relative contribution of potential ecosystem service value to calculate the service value of ecosystem functions such as water holding, gas regulation, and climate regulation. The calculation formula is:

$$ESV = \sum_{i=1}^{n} (A_i \times VC_i)$$  \hspace{2cm} (11)

$$ESV_f = \sum_{i=1}^{n} (A_i \times VC_{if})$$  \hspace{2cm} (12)

Where, $ESV$ is the ecosystem service value, $A_i$ is the area of land use type $i$, $hm^2$. $VC_i$ is the ecosystem value coefficient, $ESV_f$ is the value of ecosystem service function $f$, and $VC_{if}$ is the value coefficient of service function $f$ for land use type $i$.

### 3.2.5 Soil and water conservation benefits

For the evaluation of the benefit of keeping water and soil is mainly expressed by the change of slope loss per unit area of soil, and the benefit of keeping water and soil is calculated based on the loss per unit area of the abandoned land of Yungaisi Turquoise Mine and Yungaisi Turquoise Mine Park, which is calculated by the formula:

$$E = \sum_{i=1}^{n} \left[ \frac{1}{6} \times (a_{i1} \times h_{i1} + a_{i2} \times h_{i2} + a_{i3} \times h_{i3}) \times l_i \right]$$  \hspace{2cm} (13)

Where, $E$ is the slope loss per unit area, $a_i$ is the width of the erosion gully, $h_i$ is the depth of the erosion gully, and $l_i$ is the length of the erosion gully.

### 3.3 Evaluation of the degree of ecological damage in mining areas based on data mining technology

The eco-efficiency according to the value of correlation degree can determine the corresponding mining area ecological environment damage degree evaluation weights, and then use the data mining technology in big data to establish the mining area ecological environment damage degree evaluation model. Set the data set of evaluation of ecological damage degree of mine area as $\{ (x_i, y_i) \}$, $i = 1, 2, \ldots, n$. $x_i$ indicates the evaluation index of ecological damage degree of mine area, $y_i$ indicates the corresponding value of ecological damage degree of mine area, and the following equation can be designed according to the working principle of support vector machine:
\[ f(x) = w^T \varphi(x) + b \] (14)

Based on the principle of structural risk minimization, an equivalent objective estimation function with constraints can be established as:

\[
\begin{align*}
\min & \| \omega \|^2 + \frac{1}{2} C \sum_{i=1}^{n} \xi_i^2 \\
\text{s.t.} & \begin{cases} 
y_i - w^T \varphi(x) + b = e_i \\
i = 1, 2, \ldots, n
\end{cases}
\end{align*}
\] (15)

(16)

Establish the following Lagrangian multiplication function:

\[
L(w, b, \zeta, \alpha) = \min \| \omega \|^2 + \frac{1}{2} C \sum_{i=1}^{n} \xi_i^2 + \\
\sum_{i=1}^{n} \alpha_i \left( \omega^T \varphi(x) - b + e_i - y_i \right)
\] (17)

The kernel function is introduced instead of the inner product operation, as follows:

\[
K(x_i, x_j) = \varphi(x_i)^T \varphi(x_j)
\] (18)

Radial basis functions are used as kernel functions, which are defined as follows:

\[
k(x_i, x_j) = \exp \left( -\frac{\|x_i - x_j\|^2}{2\sigma^2} \right)
\] (19)

According to \( \alpha_i \) and \( b \), the decision function for the evaluation of the degree of ecological damage in mining areas based on the support vector machine can be obtained as:

\[
f(x) = \sum_{i=1}^{N} \alpha_i \exp \left( -\frac{\|x_i - x\|^2}{2\sigma^2} \right) + b
\] (20)

4 Benefit analysis of tourism resources development in Yungaisi turquoise mining area

4.1 Tourism resource-based rehabilitation of mine waste sites

This paper focuses on the main types of wasteland in the Yungaisi turquoise mine area and the principles of zoning and phasing for mine wasteland restoration. The planning scope for the environmental remediation and ecological restoration of the Yungaisi turquoise mine includes the north mine area of Yeshan Iron Mine. Based on the geographical location of the mine, the importance of the treatment area, the complexity of the geological and environmental conditions in the treatment area, the guiding ideology, basic principles and objectives of the plan, and the construction of the mine park, zoning and phased treatment are carried out.
The land damage characteristics and geological hazards in the mine mainly include crumbling, ground fractures, unstable slopes caused by mining and pit negligence in drainage, in addition to crumbling and unstable slopes caused by solid waste accumulation, etc. Combined with the mine geological environmental protection and treatment and restoration program preparation specifications, the four phases of my wasteland tourism resource-based restoration are proposed for phased implementation, as shown in Table 2.

Table 2. Governance partition table by stages

<table>
<thead>
<tr>
<th>Governance Staging</th>
<th>Treatment Zones</th>
<th>Implementation Period</th>
<th>Main project content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I Project</td>
<td>Environmental remediation implementation area</td>
<td>2 years</td>
<td>Mine Environmental Treatment</td>
</tr>
<tr>
<td>Phase II Project</td>
<td>Mining waste land, abandoned production facilities area</td>
<td>2 years</td>
<td>Mine Environmental Treatment</td>
</tr>
<tr>
<td>Phase III Project</td>
<td>North slope of the pit</td>
<td>2 years</td>
<td>Mine Park Construction</td>
</tr>
<tr>
<td>Phase IV Project</td>
<td>Southern part of the pit and the bottom of the pit</td>
<td>1 year</td>
<td>Mine Environment Treatment</td>
</tr>
</tbody>
</table>

Roads and drainage in the treatment area:

1) Set up the main road and simple walkway in the treatment area, road greening to take into account the environmental greening effect and certain visual permeability on both sides of the main road in the treatment area, 2.5m from the road on both sides of the road, each planted a row of seedlings to form a continuous forest belt.

2) Drainage ditch in the treatment area: set drainage ditch on both sides of the main road, the foot of the slope, and around the treatment area, using stone or brick slurry, length of about 3500m.

3) Set up walls around the treatment area, using concrete hollow brick masonry, wall height 1.5m, 20cm thick, including the treatment area of Tieshigang, a total length of 4450m.

4) To meet the needs of vegetation maintenance and landscape construction, a cistern was built in the eastern part of the treatment area using the existing quarry pits. The reservoir area is about 383.51 m² and the depth is about 5m.

4.2 Analysis of ecological restoration results of vegetation in turquoise mining parks

4.2.1 Results of greening restoration in the eastern part of the mine

The eastern part of the mine includes three areas: the waste mine dump slope, the mining pit, and the abandoned land.

1) Greening of the slope of the waste mine dump

The planting and sowing of seedlings on the slope covers an area of about 8,450 m², and the planting method is grouped. The plant configuration uses the seasonal phase of plants with high ornamental value and distinctive characteristics to give seasonal inspiration, enhance the sense of season and show the unique artistic effect of plants in the garden landscape. You can use a mixture of trees with different flowering periods, increase evergreen trees and herbaceous flowers and other methods to extend the ornamental period, and trees and shrubs dominate the upper layer of the plant community. Figure 7 outlines the planting plant configuration and quantity in this area.
2) Greening of the slope of the mining pit

The area of seedling planting and sowing on the slope is about 4009.73m², using group planting methods to plant seedlings and sow grass seeds on the open mining slope. The plant arrangement uses suitable grass and wood, which is both green and colorful and takes full advantage of the space near the slope. The unified construction of three-dimensional plant communities combining trees, shrubs and grasses enhances the stability of slope vegetation communities, increases the leaf area index and greening coverage, but also helps to improve ecological benefits and environmental quality. The plant configuration and quantity of seedling planting and grass seeding in this area can be seen in Figure 8.

3) Greening of abandoned land

The greening area of this area is about 16008.82m², and the vegetation restoration is carried out after the terrain remediation combined with land reclamation, and the natural type group planting method is adopted. This zone has a large area. To enrich the greening effect of the environment and improve the ecological position of the plant community, planting is carried out by the natural, ecological and plant diversity configuration while planting in the mine greening. The planting of trees, shrubs, grasses, vines, flowers, evergreen and deciduous, broad-leaved and coniferous, foliage and fruit trees, etc., with good and strong seedlings, planted in patches and groups, sparsely and densely, and grass
on the ground, laying the foundation for the construction of Yungaisi Mine Park. Figure 9 illustrates the configuration and quantity of green plants in this area.

![Figure 9](image-url)  
**Figure 9.** Abandoned areas plant configuration

### 4.2.2 Results of ecological restoration in the western part of the mine

The area's greening is divided into two parts: the slope of the waste mine dump and the greening of the abandoned land.

1) Greening of the slope of the waste mine dump

The green area of this area is about 18,359.25 m², planted in groups. This area is close to the core of the mine park construction, so the total landscape construction is very important. To combine with the landscape characteristics of the park later, the greening of this area mainly adopts a large color block plant background for landscape creation, which is coordinated with the magnificent natural geological landscape of the mine park, and planting is carried out following the natural, ecological and construction plant diversity configuration. Planting trees, shrubs, grasses, vines, flowers, evergreen and deciduous, broad-leaved and coniferous, foliage and fruit trees, etc., are reasonably distributed, and good and strong seedlings are used. Figure 10 depicts the arrangement and amount of green plants in this area.

![Figure 10](image-url)  
**Figure 10.** Waste ore yard slope area plant configuration
2) Greening of the abandoned land

The greening area of the abandoned area is about 5433.12 m², and then the park will be constructed by planting seedlings and sowing grass seeds, and the natural group planting method will be used to restore the vegetation environment to lay the foundation for the construction of the national mine park. Figure 11 displays the configuration and quantity of green plants in the area.

![Figure 11. Abandoned areas plant configuration](image)

5 Conclusion

This study explores the sustainable development of tourism resources in abandoned gemstone mining areas by taking turquoise mining in the Yungaisi area as an example and combining it with big data technology. The application and role of big data technology in the development of tourism resources in abandoned mining areas are discussed, and finally, the benefits of tourism resource development of turquoise mining in the Yungaisi area are evaluated and analyzed.

This paper's main conclusions are as follows:

This study uses big data technology to evaluate and analyze the ecological environment of abandoned mining areas and to evaluate and analyze the type, quality, and quantity of tourism resources to provide scientific basis and decision support for the sustainable development of tourism resources in abandoned mining areas.

This study aims to evaluate and analyze the benefits of tourism resource development in mining areas, taking turquoise mining in the Yungaisi area as a case study. The research results show that the increase of seedling planting on the eastern slope of the Yungaisi turquoise mining area is about 8450 m², the increase of the greening area of abandoned land is about 16008.82 m², and the increase of greening of waste mine pile in the west is about 18359.25 m², which realizes the sustainable development of Yungaisi scenic area. Based on the rehabilitation of tourism resourcefulness and greening of the abandoned mine area, the development of tourism resources in the abandoned mine area can bring positive benefits to local economic development and social welfare enhancement.
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