Spatial Ecological Restoration of the Three-Level Mountain in Taishan Area based on GIS Technology

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Abstract

As non-renewable characteristic natural landscape resource in the city, mountains are essential to urban ecological environment protection, landscape shaping and improvement in quality of life. The Taishan Mountains, as the ecological framework of the North China Plain, are listed as "the world's cultural and natural double heritage". In 2019, the Taishan Mountains were rated as a global geological park. The protection of ecological safety in Taishan has a long way to go. The three-level Mountains surrounding the Taishan Mountains are an important part of it, which is closely connected with residents' lives as provider of important resources for residents' production and life. However, current research and spatial identification of these three-level mountains is insufficient. Taking the Baimasi Mountain in Taishan area as an example, this paper explains the ways and methods to apply ARCGIS technology in the spatial organization of Baimasi Mountain in the Taishan area. By using GIS to analyze mountain data including slope, exposure, elevation and other spatial data, it provides certain data support for the spatial organization planning, landscape design, and tourism development of the mountain.

Keywords: *Taishan area, GIS technology, three-level Mountains, spatial identification, ecological restoration*

I. Introduction

In the 2019 Report of the Shandong Provincial Department of Natural Resources on the Work of Natural Resources [1], it was pointed out that through vigorous implementation of land greening action under the theme of "Green, Beautiful Shandong", 5.48 million mu afforestation in total has been accumulatively completed in the past three years. Thanks to strengthened protection and management of nature reserves, there are 169 national nature reserves in the province, of which Mount Tai and Mount Yimeng are world geoparks. As non-renewable characteristic natural landscape resource in the city, mountains are essential to urban ecological environment protection, landscape shaping and improvement in quality of life.

The current mountain space research mainly focuses on ecological restoration technologies and methods, with emphasis on status quo protection. The practice centers on the three aspects of ecological restoration technology, mountain vegetation landscape optimization, mountain protection planning and control, lacking research in identification of current mountain space characteristics and spatial risk evaluation in the early stage, dynamic monitoring of post-restoration effects, and later-stage tourism development.

At present, in mountain space plan design, designer draws draft drawings, then performs two-dimensional deepening design via design assistant software AutoCAD [2], and finally plots by SU software or 3D software. The entire mountain space design process is oriented to design result rather than design process. As a result, the plan design is separated from the previous status quo analysis and the later engineering effect supervision, resulting in laborious post-production work such as analysis diagram production and index statistics [3]. On the contrary, in the mountain space organization, data analysis based on GIS software can truly combine design with analysis [3].

II. Manuscript Preparation

2.1 GIS technology-based elevation data analysis of Baimasi Mountain space

2.1.1 Source of information

Download the raster map of Baimasi in Taishan area in the required TIF format from the Internet, link the downloaded TIF map to ArcGIS 10.6 software, open the raster map points to add data, and after the addition, one will get the most original elevation data [4] (*Fig. 1*).

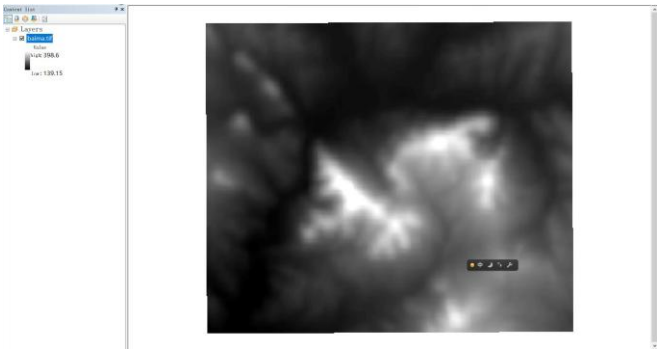

Fig. 1: Elevation data graph.

2.1.2 Perform elevation analysis of Baimasi Mountain

Click the ARCGIS 10.6 software to perform elevation analysis of Baimasi mountain, right-click the Baimasi raster map linked to the software, click the software attribute, select the symbol system, find the classification on the right side of the status bar, select the desired ribbon and click OK *(Fig. 2).*

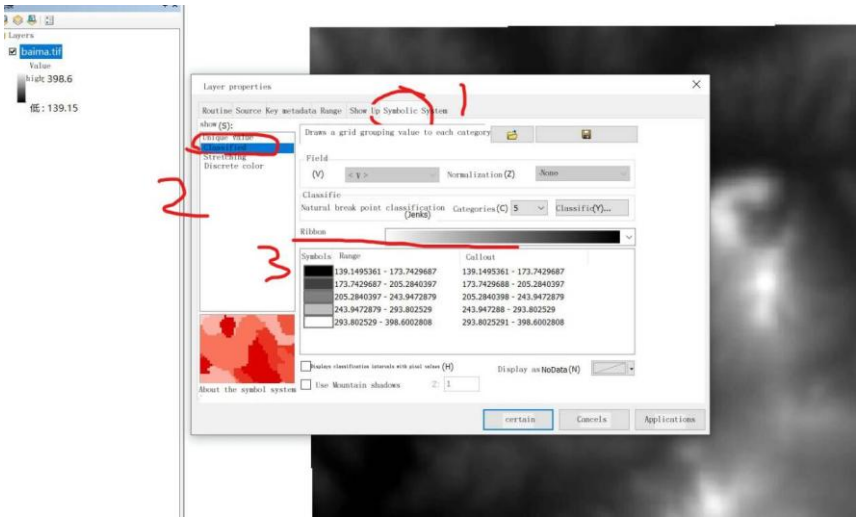

Fig. 2: The operation process.

2.1.3 Click export map

After selecting the elevation color value in the ARCGIS 10.6 software, one can click Export Map to get the elevation data map of Baimasi Mountain *(Fig. 3).*

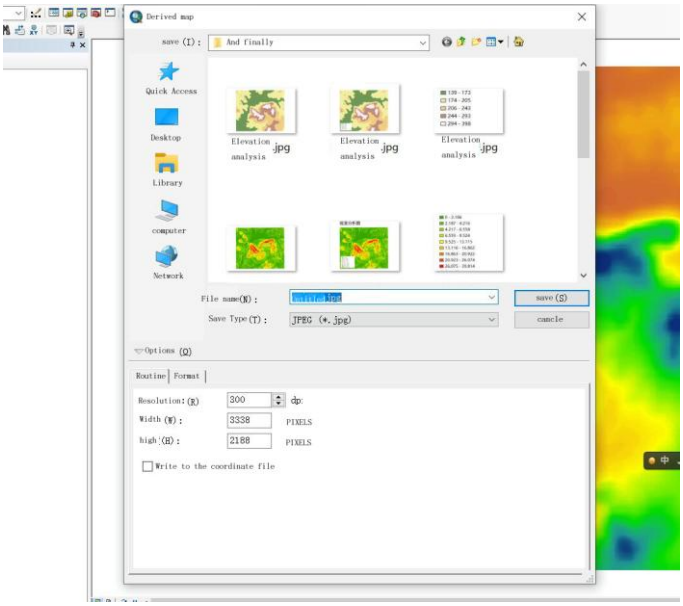

Fig. 3: Elevation data of White Horse Temple Mountain.

2.2 GIS technology-based exposure data analysis of Baimasi mountain space

2.2.1 Click export map of Baimasi

Download the raster map of Baimasi in Taishan area in the required TIF format from the Internet, link the downloaded TIF map to the ArcGIS 10.6 software, open the raster map points to add data, and after the addition, one will get the most original exposure data graph [5].

2.2.2 Select all the options inside

When using ARCGIS 10.6 software for the first time, one need first open the 3D tool in the software, find Custom in the taskbar, click the extension module in the custom tool, and select all the options inside [6] *(Fig. 4).*

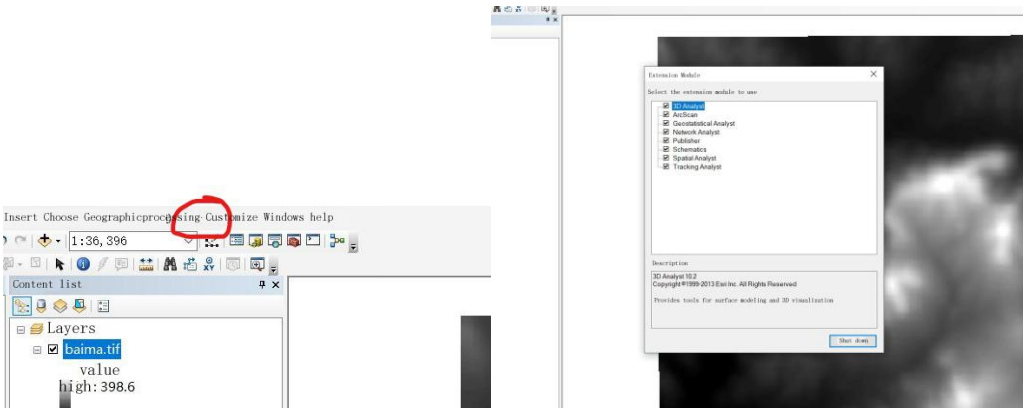

Fig. 4: Select the module in custom.

2.2.3 Exposure Analysis

Find the 3d tool in the taskbar and open 3D Analyst Tool -> Raster Surface -> Exposure in turn, select the added raster map in Exposure, click OK and wait for completion (*Fig. 5).*

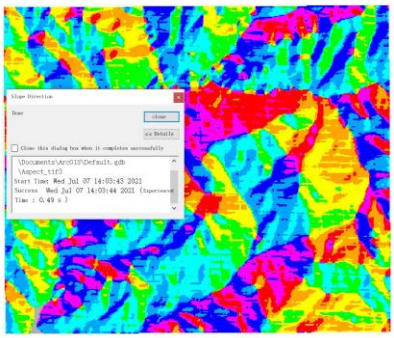

Fig. 5: Select the module in 3D Analysis.

2.3 GIS technology-based exposure data analysis of Baimasi mountain space

2.3.1 Slope analysis of Baimasi

Based on the original Baimasi raster map in TIF format, find the slope analysis tool among the 3D tools of ARCGIS 10.6 software, and add raster map to the slope (*Fig. 6*).Click OK and wait for completion of the Baimasi mountain slope analysis (*Fig. 7).*

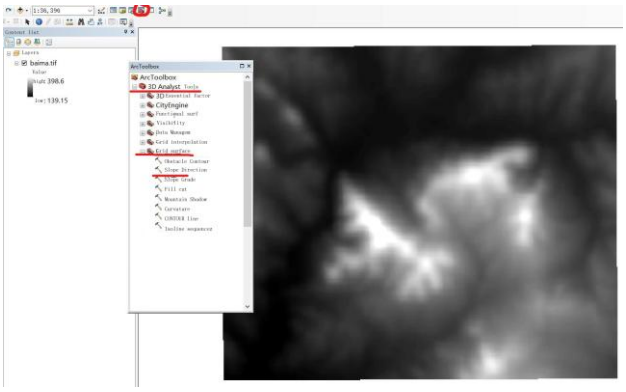

Fig. 6: the slope analysis tool among the 3D tools of ARCGIS 10.6 software.

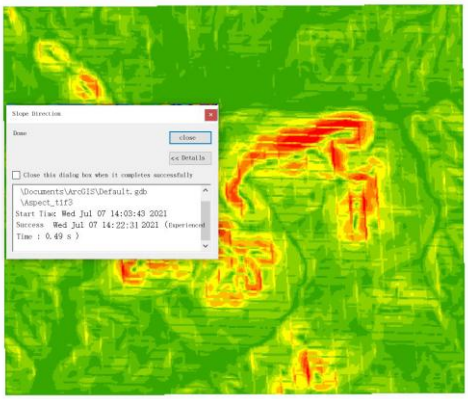

Fig. 7: Baimasi mountain slope analysis.

2.4 Spatial planning of Baimasi Mountain in Taishan area

2.4.1 Perform spatial analysis on Baimasi mountain using GIS technology, and gather elevation data, slope analysis data, and exposure analysis data (*Fig. 8).*

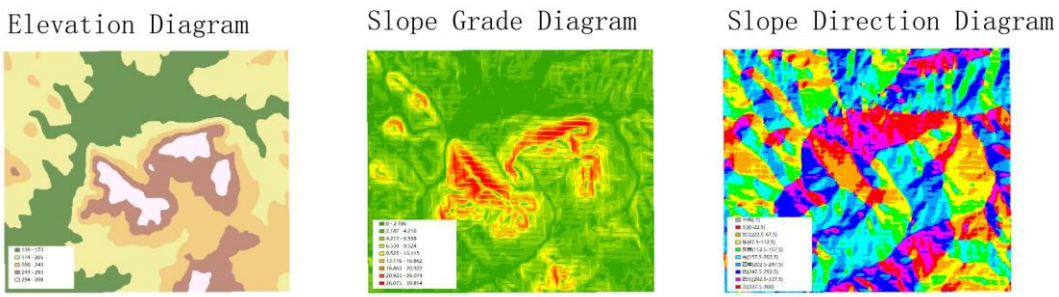

Fig. 8: Elevation analysis diagram, slope analysis diagram, exposure analysis diagram.

Elevation analysis: Baimasi mountain site has relatively small elevation change, the highest point is 410 meters above sea level, and the terrain is low in the north and high in the south. Slope analysis: the mountain slope varies greatly, most mountain slopes are concentrated between 2-9 degrees, but the slope height difference is as large as 37 degrees. Exposure analysis: the inner mountain is in the north slope direction [7, 8].

2.4.2 Analysis of the advantages and disadvantages of Baimasi Mountain
Advantage analysis: there are relatively superior location conditions, convenient transportation, rich topography, multiple valleys and peaks, several construction facilities surrounding Baimasi, rich cultural heritage, and relatively complete infrastructure around the Baimasi;

Disadvantage analysis: The project base with poor site conditions is difficult to construct, there are exposed mountains with hidden safety hazards. The current vegetation is mainly Platycladus orientalis and the landscape is relatively simple [9].

2.4.3 Baima mountain restoration positioning
Located in the southern part of Taishan Mountains, Baima Mountain plays an important role in ecological service in the southern region. Therefore, we define mountain space restoration as mountain landscape that integrates vegetation restoration and ecological services. Following elevated greening standards, it lets citizens truly feel the unique culture of the global geopark, pays attention to mountain greening design, and makes good use of landscape trees so that the mountain "presents different scenes in different seasons" [10].

2.4.4 The project design principles
(1) Principle of integrity: According to the site characteristics, topography and geomorphology, the landscape design should be considered as a whole, not only considering the integrity of the landscape design itself, but also the connection between Taishan Scenic Area and the surrounding Baimasi to make it a whole.

(2) Ecological principle: Based on the principles of ecology and botany, combine greening with mountainous terrain, and ecology with health. The green landscape should have proper trees in proper sites to form a community, showing spatial density, opening and closing changes.

(3) Principle of adapting measures to local conditions: The design should be based on analysis of the current conditions such as elevation and exposure, comprehensively considering selection of various influencing factors, and implementing in a way suitable for the site. Native tree species should be selected without damaging the original ecological environment as far as possible.

(4) Safety principle: The height difference within the base varies greatly, and retaining walls, steps, steep slopes, etc. may constitute safety hazards. The plan is designed with safety as an important principle to meet people's demand for safe parade and corresponding activities.

(5) Principle of economic practicability: in mountain greening, we should make full use of local seedling sources and mature afforestation technology in selection of mountain greening tree species, avoid blindly pursuing new, strange, special and one-time scenery, and fully consider the cost of later maintenance.

2.4.5 Project design strategy

For ecological restoration of Taishan third-level mountains around Baimasi, we should protect the existing mountains and its vegetation to create a diverse and continuous habitat for animals and plants; adopt technical means to build infrastructure like fish scale pits to restore the broken mountain ecology; enrich the seasonal landscape of vegetation through plants configuration; combine engineering measures and biotechnology to comprehensively perfect the mountain, eliminate geological disasters, increase vegetation coverage, and reduce mountain exposure; use GIS technology to monitor the forest resources in Baima Mountain space as well as land resource utilization status in later stage.

III. Conclusion

The Taishan Mountains, as the ecological framework of the North China Plain, are listed as "the world's cultural and natural double heritage". There is a long way to go in protecting the ecological safety of Mount Tai and optimizing its tourism resources. The mountain under three-level protection, as an important part of Taishan Mountains, involves several mountains mainly distributed in the Taishan branch and surrounding mountains around Tai'an City. The investigation and control of the remaining three-level mountains of Taishan is a problem demanding urgent solution. To promote the sustainable development of ecological tourism in Taishan area, there is need to provide management strategies and suggestions for the construction of legislative system by the garden housing construction and management departments, thus providing new mechanism for the conversion of new and old functions in our province.

With powerful spatial analysis capabilities, to a large extent, ARCGIS helps designers conduct rational data analysis, intuitively establish models for mountain spatial design plans, select design areas more accurately, and evaluate project implementation effects more effectively, thereby effectively reducing emphasis on text and renderings in the traditional mountain space design [3]. With the in-depth study of related knowledge, ARCGIS technology is used to perform data analysis, spatial planning, development and reuse, and post-spatial restoration supervision of these mountain spaces, which improves data and scientific nature in mountain space landscape design, as well as effectiveness in later project construction implementation.

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