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Spatial Distribution Characteristics of Color Steel Plate Buildings in Lanzhou City

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Abstract: Color steel plate building has the characteristics of beautiful appearance, low cost, light weight and fast construction speed. It is an important product in the rapid development of the city. It is widely distributed in urban villages, urban fringe, new technology development zones, construction sites and other plots.Its spatial distribution has obvious aggregation characteristics and regularity. This paper takes the four main urban districts of Lanzhou as the research area. Based on the 2017 remote sensing image and urban regional vector boundary data, the GIS platform is used to obtain the color steel plate building vector data by human-computer interaction interpretation, using buffer analysis method, spatial statistical method, etc, the spatial distribution characteristics of color steel plate buildings in the study area were discussed. The results show that the building density of color steel plate decreases with the distance from the Yellow River, which is consistent with the logarithmic model. As the distance from the city center increases, the overall decline, rising at 4-6km, 12-16km. The density of color steel plates in each street shows a strong positive spatial autocorrelation. Significant “low-low” streets are mainly distributed at the junction of Anning District and Qilihe District and the southern part of Chengguan District. Significant “low-low” streets are mainly distributed in the western part of Xigu District, the western part of Chengguan District and two townships in the south of Qilihe District. The Gongxingdun Street in Chengguan District is a “low-high” type. Studying the distribution law of color steel plate construction can effectively assess the degree of urban development equilibrium, and can avoid the disorderly expansion of urban land use, which has important reference significance for the future development planning of developing cities.

Key words: color steel plate buildings; buffer analysis method; distribution characteristics

1. Introduction

Temporary color steel plate construction is widely used in urban construction. With the optimization and upgrading of the urban spatial structure and functional system [1], the size and use of the color steel plate building and the original color steel plate building gathering area will also show a significant spatial restructuring trend. Therefore, the spatial distribution of color steel plate construction and the evolution of urban spatial form must be related. Therefore, studying the spatial distribution characteristics of Lanzhou city’s color steel plate building is of great significance for analyzing the urban spatial form of Lanzhou City. At present, research has been conducted on the relationship between nighttime lighting, roads, green spaces, high-speed rails, and residential prices, as well as the evolution of urban spatial form, but there has not been any research related to color steel plate construction [2-4]. Based on the analysis of the spatial characteristics of buildings, Zhang Xiaohu studied the urban structural characteristics and changes of Beijing [5]. He Chunyang used DMSP/OLS nighttime lighting data to establish a spatial pattern of point-line urbanization in urban

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agglomerations, and analyzed the urbanization process of the Bohai Sea region in the 1990s [6]. Wang Fahui studied the relationship between urban scale system and urban internal structure from the perspective of traffic network and traffic flow, and linked the geographical environment impacts of micro and macro scales [7]. Qin Bo combined the characteristic price model with the Moran's I index to quantitatively analyze the randomly sampled Beijing residential prices [8]. This paper grasps the temporary urban color steel plate building, a new urban space element, and reveals its relationship with urban development level by analyzing the spatial distribution characteristics of Lanzhou color steel plate building.

2. Data and Research Methods

2.1 Study Area and Data

The research area of this paper is the main city of Lanzhou (Fig. 1). The main city of Lanzhou City is located in the river valley basin with a dumbbell shape in Lanzhou City. It is long and narrow, east from Sangyuan Gorge and west to Xiliugou. It is about 37.5 km long and 2-10 km wide from north to south. From the north to the Shajingyu in the Anning District, the south is bounded by the foothills of the Nanshan Mountain. Administrative boundaries include Chengguan District, Qilihe District, Xigu District and Anning District. There are 77 street offices in the main city.

The main data sources for this study included 2017 GF2 Fusion Images and Google Earth HD Images. After manual interpretation, the vector data of the color steel plate building in the main city of Lanzhou City is obtained (Fig. 2).

According to incomplete statistics, in 2017, the number of color steel plates in the main city of Lanzhou reached 34518, accounting for 0.99% of the total area of the district. The largest color steel plate construction area is 32322.81 m^2, the minimum color steel plate construction area is 2.48 m^2, and the average area is 330.51 m^2. It shows that color steel plate construction is widely used in urban construction. The blue and red buildings are color steel plate buildings (Fig. 3).

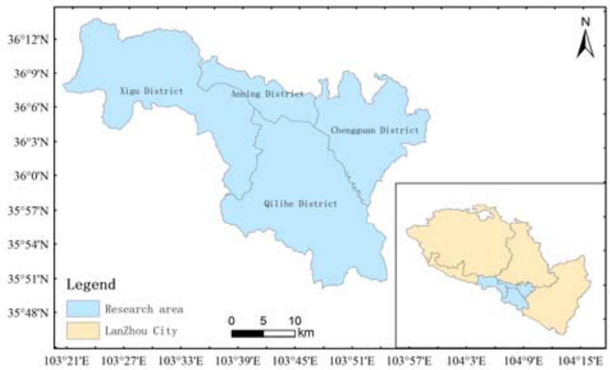

Fig. 1 Location map of the study areas.

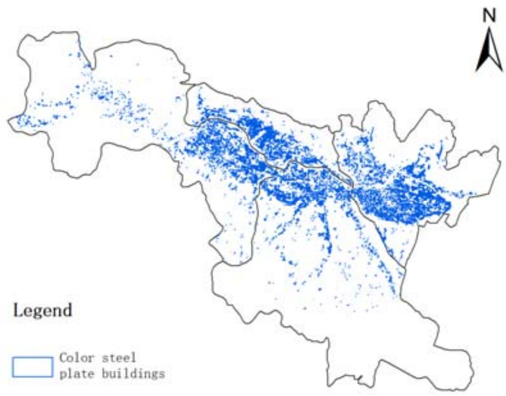

Fig. 2 Color steel plate construction extraction results of GF2 image in the study area.

1) Economic Development Zone 2) Urban-rural Integration 3) Villages in the City

Fig. 3 Temporary color steel plate construction in different urban plots.

3. Research Method

Buffer analysis is the process of generating one or more regions around a selected feature using a predefined distance from those features. The resulting buffer is one or a series of polygon objects. From a mathematical point of view, a buffer is a neighborhood of a given spatial object or collection. The size of the field is determined by the radius of the neighborhood or the conditions established by the buffer. So for a given object A, its buffer can be defined as:

$$P = \{x \,||\, d(x, A) \le r\} \quad (1)$$

Where, d generally refers to the Euclidean distance, or other distances.r is the condition of the neighborhood radius or buffer establishment.

The grading buffer analysis method is generally used to analyze the spatial characteristics of spatial elements with different buffer radii. Here, the quantitative analysis of the spatial distribution of color steel plates in the main urban area of Lanzhou is carried out. The setting of the distance parameter is mainly based on the fact that the buffer can contain most of the color steel plate buildings near the buffer object.

Spatial autocorrelation analysis studies the degree of similarity between spatial entities and their adjacent spatial entities, which can be divided into positive correlation and negative correlation. A positive correlation indicates that the change in the attribute value of a unit has the same change trend as its adjacent spatial unit, and the negative correlation is the opposite.

(1) Global Spatial Autocorrelation

The Moran index is a global indicator used to measure spatial autocorrelation. If x_i is the observed value of position (region) i, the global Moran index I of the variable is calculated by the following formula:

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\sum_{i=1}^{n}(x_i - \bar{x})^2} \quad (2)$$

Where, I is the Moran index; w_{ij} is the spatial weight.The Moran index I is generally between [-1, 1], less than 0 means negative correlation, 0 means irrelevant, and greater than 0 means positive correlation.

(2) Local Spatial Autocorrelation

If further consideration is given to whether there is a high or low value local spatial agglomeration of observations, which regional unit contributes the most to the global spatial autocorrelation, local spatial autocorrelation analysis must be performed. The local Moran index Ii in the local indicator of spatial association (abbreviated as LISA) is calculated as follows:

$$I_i = \frac{n(x_i - \bar{x})\sum_j w_{ij}(x_j - \bar{x})}{\sum_i (x_i - \bar{x})^2} \quad (3)$$

The meaning of each variable in the formula is the same as formula (2).

Analysis of Spatial Expansion Distribution of Color Steel Plate Building

Taking into account the characteristics of urban space development in Lanzhou City, in the buffer analysis, the two modes of point center and face center were adopted respectively, with the municipal government as the center and the Yellow River as the axis and 2000 m as the radius [9].

3.1 Downtown-centered Buffer Analysis

Centered on the municipal government, a buffer analysis of the radius of 2000 m ensures coverage of all color steel plates (Fig. 4). The total area of the color steel plate in each radius buffer and the total land area are separately counted. The total area of the color steel plate is divided by the land area to obtain the density of the color steel plate in each radius buffer. Draw a density-distance curve (Fig. 5).

As can be seen from the graph, on the whole, the density of the color steel plate building in each radius buffer decreases with the distance from the city center,

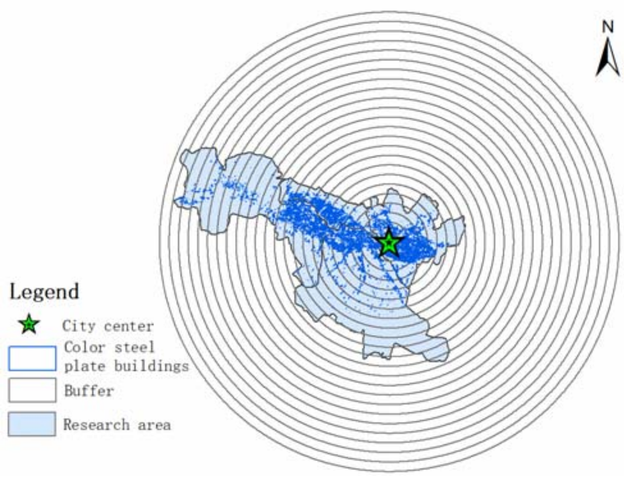

Fig. 4 Schematic diagram of downtown buffer analysis.

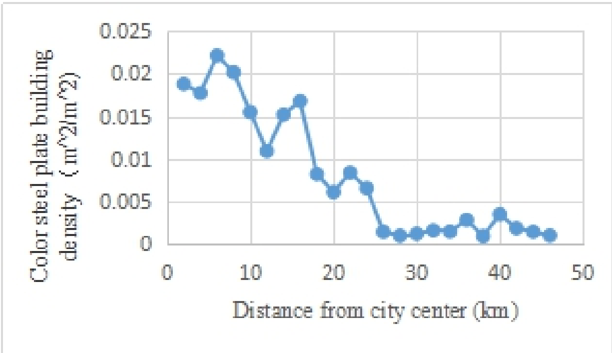

Fig. 5 Change in density of color steel plate building centered on the city center.

and the color steel plate construction density is the largest at 6 km from the city center, at 6-12 km, 16-18 km, a sharp drop occurred, rising at 4-6 km, 12-16 km, and then slowly decreasing from 26-46 km.

3.2 Buffer Analysis with the Yellow River as the Axis

Taking the Yellow River as the axis and 2000 m as the radius, the 12-level buffer analysis of the Yellow River is carried out, and the analysis chart of the Yellow River grading buffer in the main city of Lanzhou is as shown (Fig. 6). The calculation of the building density of the color steel plates in each radius buffer is performed as above. Draw a density-distance curve as shown (Fig. 7).

As can be seen from the graph, on the whole, the density of the color steel plate building in each radius buffer decreases with the distance from the Yellow River, and there is no color steel plate construction

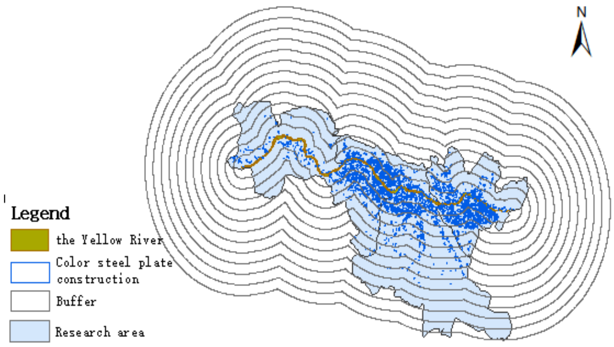

Fig. 6 Schematic diagram of the Yellow River buffer analysis.

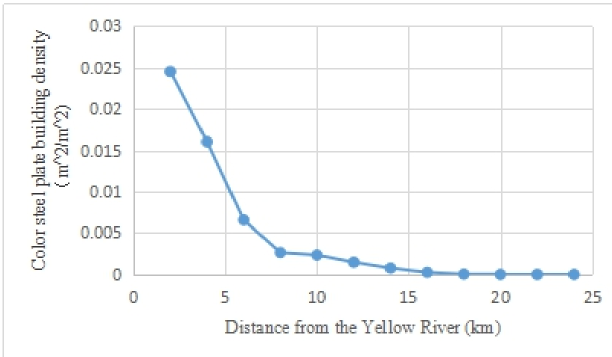

Fig. 7 Change in density of color steel plate building with the Yellow River as the axis.

after 20 km, which is slowly decreasing from 8 km. The logarithmic model is presented as a whole, and the color steel plate construction distance-density function is as follows:

$$y = -0.01\ln(x) + 0.27 \tag{4}$$

Where, y represents the building density of color steel plates in different radius buffers. x indicates the distance from the Yellow River and the fit is good (R2 = 0.872).

In summary, the analysis of the buffer zone with the Yellow River as the axis is better than the analysis of the buffer zone centered on the city center. The density of color steel plates in the central area is generally high, indicating that there are still a large number of temporary color steel plate buildings in the main city of Lanzhou, and Lanzhou has a low level of urbanization. The density of color steel plate construction in the city center is relatively low compared to the color steel plate construction of 4-5 km from the city center, indicating that the color steel plate building in the city center is decreasing, and Lanzhou is developing rapidly.

4. Analysis of the Agglomeration Distribution of Color Steel Plate Buildings in Space

The spatial autocorrelation statistic can describe the potential interdependence or the close relationship between the observation data of variables in the same distribution area. It is often used to analyze the spatial agglomeration and change trend of geographic elements, and to explore the temporal and spatial agglomeration and evolution of elements. Provide evidence. In this paper, the study area is divided into administrative streets, with a total of 77 streets. The color steel plate construction area and street area of each street are separately counted, and the color steel plate building density of each street is obtained [10-11].

4.1 Global Spatial Autocorrelation Analysis

Using Arcgis spatial analysis to calculate the global spatial autocorrelation index Moran index I, the results are shown in Table 1.

It can be seen from Table 1 that I = 0.265458 > 0, at a significant level of 0.001, z > 1.96, indicating that there is a positive spatial autocorrelation between the building density of each street color steel plate, that is, a similar high value or low value exists space gathering.

4.2 Local Spatial Autocorrelation Analysis

Using the OpenGeoDa software to draw Moran scatter plots (Fig. 8), it can be seen that there are sample point distributions within the four quadrants, but there are more points distributed in the first and third quadrants, indicating the color steel between the streets. The spatial autocorrelation method of shed building density is mainly the aggregation of high and high values, and the aggregation of low and low values. The number of "low-low" streets in the third quadrant is much larger than the number of "high-high" streets in the first quadrant, indicating that the low-value agglomeration has a larger number and a wider distribution than the high-value cluster.

Table 1 Global moran index of building density of color steel sheds in each street and its test.

Variable	I	z-score	p-value
Color steel plate buildings density	0.265458	4.030186	0.000056

In order to identify the changes in local spatial agglomeration, we focus on the local spatial agglomeration index with a high level of significance (using the significance level of 0.05), and finally obtain the LISA agglomeration map as shown (Fig. 9). It is not obvious that the streets are the widest, mainly distributed in the southwest and northeast regions. There are 9 prominent "high-high" streets, mainly located at the junction of Anning District and Qilihe District and the southern part of Chengguan District. There are seven prominent "low-low" streets, mainly distributed in the west of Xigu District, the western part of Chengguan District and two townships in the south of Qilihe District. There is one "low-high" type street, which is distributed in Gongxingdun Street in Chengguan District.

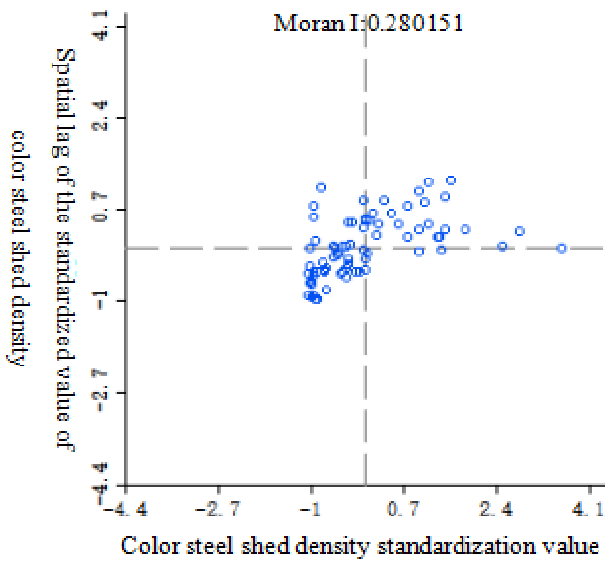

Fig. 8 Scatter plot of density of color steel plate buildings in each street.

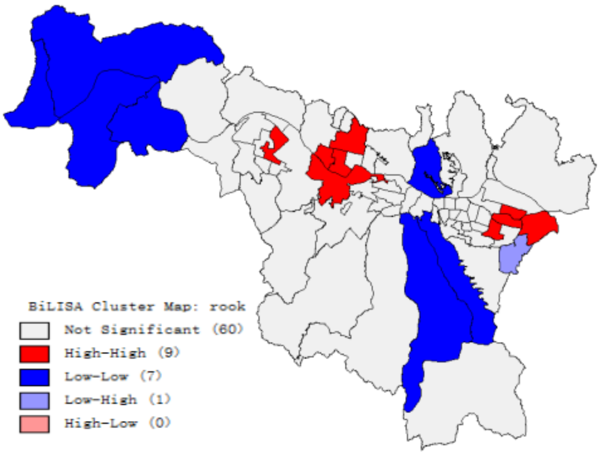

Fig. 9 LISA aggregation map of the density of color steel plate buildings in each street.

Table 2 Significant "high-high" streets and significant "low-low" streets.

High-high	Low-low
Xigucheng Street	Dongchuan Town
Jiayuguan Road Street	Dachuan Town
Gongxingdun Street	Hekou Town
Donggang Street	Weiling Township
High-tech district street	Bali Town
West Road Street	Jingyuan Road Street
Yintan Road Street	
Liujiabao Street	

5. Conclusion

This paper analyzes the expansion and aggregation distribution characteristics of Lanzhou color steel plate construction and draws the following conclusions:

(1) Using the buffer analysis, the building density of the color steel plate decreases with the distance from the Yellow River, which is in line with the logarithmic model. As the distance from the city center increases, it increases and decreases, increases and decreases, and decreases overall.

(2) Spatial autocorrelation analysis is used to study the interdependence of color density of various color steel plates in various districts. It is concluded that significant "low-low" streets are mainly distributed at the junction of Anning District and Qilihe District and the southern part of Chengguan District. Significant "low-low" streets are mainly distributed in the western part of Xigu District, the western part of Chengguan District and two townships in the south of Qilihe District. The Gongxingdun Street in Chengguan District is a "low-high" type.Studying the spatial distribution characteristics of color steel plate buildings can effectively assess the degree of urban development equilibrium and provide a basis for the government to centrally rectify the "villages in the city".

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