Residential Land Price of Qingdao City Based on GWR Model Study on Spatial Differentiation and Influencing Factors

Wenqi Kang*

Beijing Jiaotong University, Beijing, China

17852845628@163.com

Abstract. This paper studies the spatial differentiation of Qingdao, and the analysis is carried out based on the GWR model. Firstly, the research scope and data are determined, and then the exploratory spatial analysis (ESDA) method is used to analyze the residential land price data of Qingdao, including the establishment of histogram, spatial trend analysis and spatial autocorrelation analysis. Finally, Using GWR4.0 to determine the bandwidth and weight, then a geographically weighted regression (GWR) model can be established, which can be used to analyze the influencing factors of residential land price. The results show that the building density is inversely proportional to the price of urban residential land, and the green rate and floor area ratio are directly proportional to the price of residential land.

Keywords: Qingdao residential land price, spatial variation, GWR model

1 Introduction

As a special commodity, land price fluctuations reflect the change of urban land supply and demand relationship to a certain extent, reflecting the strength of urban economic activities [1]. Exploring residential land price in Qingdao through GWR model can overcome the spatial non-stationary limitations. With the help of ArcGIS software, SPSS 23 and other software, qualitative analysis and quantitative analysis are combined. This research method provides a new idea for the study of factors affecting urban land price, and the method is conducive to the local government's land management work, which also provides reference for the formulation and analysis of land policies. This kind of research can also provide data support for urban economics.

Y. Zhang et al. (eds.), *Proceedings of the 2024 10th International Conference on Architectural, Civil and Hydraulic Engineering (ICACHE 2024)*, Advances in Engineering Research 259,
https://doi.org/10.2991/978-94-6463-658-1_74

2 Research Methods and Data Sources

2.1 Research Methods

2.1.1 Exploratory Spatial Data Analysis (ESDA).

ESDA combines the statistical principles, graphs and charts, so as to determine the model structure and the corresponding solution more clearly. Common ESDA tools include histograms, normal QQ graphs and trend analysis. In this paper, before doing the spatial autocorrelation analysis, it is necessary to first explore whether the data meets the premise of normal distribution. The histogram is established to determine whether the data follows normal distribution. ArcMap 10.5 software is used to analyze the spatial trend of the land price sample points, determine the spatial differentiation characteristics of land price, and use Moran's I index to perform spatial autocorrelation analysis.

2.1.2 Geographically Weighted Regression (GWR) Model.

GWR model is a classical local spatial regression model, which can decompose all global parameters into local parameters for estimation and calculation [2]. When estimating parameters of spatial location points, the non-stationarity relationship is taken into account, so the spatial non-stationarity relationship between certain indicators and impact factors of geospatial data can be explained in a deeper level [3]. The expanded model formula is as follows:

$$y_i = \beta_0(u_i, v_i) + \Sigma_{k=1}^{p} \beta_k(u_i, v_i) x_{ik} + \varepsilon_i, i = 1,2,3, \ldots, \ n \tag{1}$$

In the formula, n is the number of data samples, k is the number of explanatory variables, y_i is the dependent variable, $\beta_0(u_i, v_i)$ is the regression intercept of the i- th data sample point, (u_i, v_i) is the geospatial coordinates of the i-th data point, and $\beta_k(u_i, v_i)$ is the k-th value at the i-th point[3]. In general, ε_i represents the random error term of the model, and its value follows a normal distribution [4].

The value of $\beta_0(u_i, v_i)$ requires a combination of weight and bandwidth, in this paper, GWR4.0 will be used to calculate the optimal bandwidth and generate the regression coefficient table of $\beta_0(u_i, v_i)$.

2.2 Data Sources

The spatial scope of the sample data of Qingdao is the land that can carry out urban construction in the urban area of Qingdao, including the permitted construction area, the current construction land, the new construction area and the conditional construction area. It mainly includes seven districts: Chengyang District, Shibei District, Shinan District, Huangdao District, Laoshan District, Licang District and Jimo District. The research scope is based on Master Plan for Land Use of Qingdao (2006-2020) (http://zrzygh.qingdao.gov.cn/).The data of Qingdao residential land price transaction average price below is sourced from the data published on Qingdao public resources

trading electronic service system(https://ggzy.qingdao.gov.cn/). The average transaction price of residential land from April to September 2024 is shown in Fig.1:

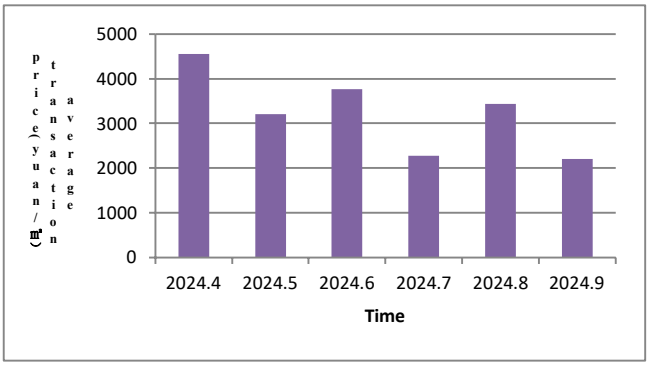

Fig. 1. Qingdao Residential Sample Point Histogram

3 Results and Analysis

3.1 The Sample Point Data Satisfy the Normal Distribution

As shown in Fig.2, The histogram was established by SPSS 23 software, it proves the sample point data of residential land price in Qingdao meets the normal distribution condition.

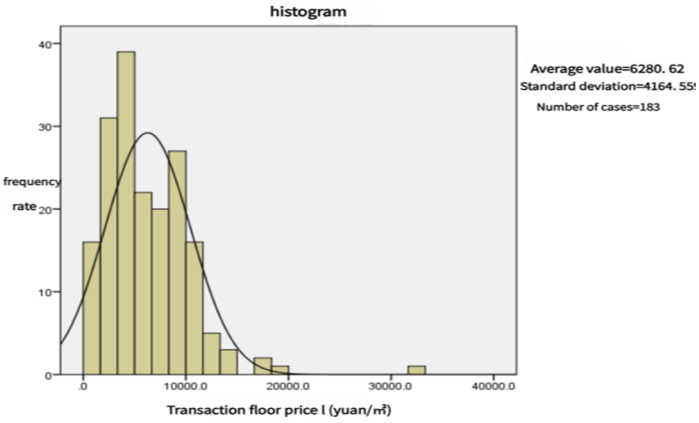

Fig. 2. Transaction Floor Price of Qingdao

3.2 Spatial Trend Analysis

The trend analysis tool of Geostatistical Analyst module in ArcGIS 10.5 was used to analyze the spatial trend of the residential land price sample points in Qingdao [6]. In

the software simulation, the geographical locations of the residential land price samples were first imported into the software. A total of 189 sampling points were selected, and 183 were actually effective. The locations of corresponding sample points in the map of Qingdao are shown in Fig.3.

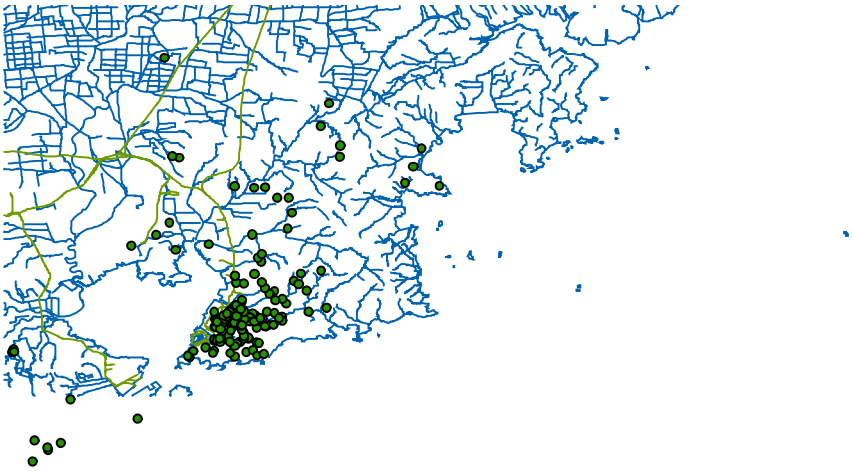

Fig. 3. Qingdao Residential Land Sample Point Map

Conduct spatial trend analysis of land price data, as shown in Fig.4, In terms of longitude and latitude, the residential land price in Qingdao shows an inverted U-shaped feature. In the longitude direction, the residential land price from south to north presents a distribution of first low and then high and then low; in the latitude direction, the residential land price from west to east also presents a distribution of low to high and then gradually decreasing, but the land price in the east is slightly higher than that in the west. Land prices in coastal areas are relatively higher than those in inland areas.

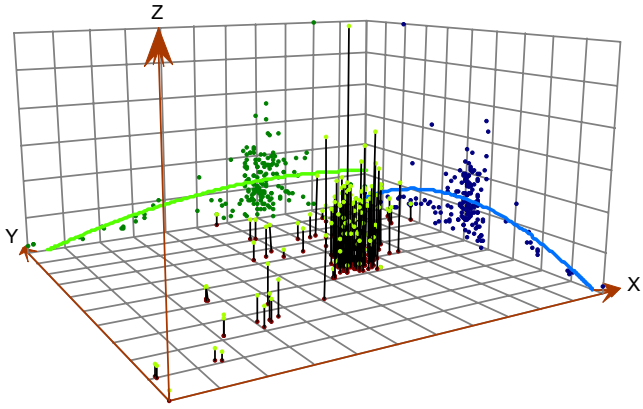

Fig. 4. Spatial Trend Analysis of Residential Sample Points in Qingdao City

3.3 Geographical Weighted Regression (GWR) Model Analysis

Using GWR4.0 to calculate bandwidth, the results are shown in Table 1.

Table 1. Bandwidth Result Table

Bandwidth determination method	nuclear space power plant	bandwidth（m）	Condition
AIC	fixed pattern	3559.242507	Minimum AIC
	adjustable type	3538.862968	Minimum AIC

In the analysis of GWR model, one sample corresponds to one regression coefficient. A total of 182 land price sample points and 3 influence factors were selected. The regression analysis of land price sample points was carried out by GWR4.0, and 182*3 regression coefficients were obtained, see attachment for details.

Based on the regression coefficients of various influencing factors obtained by GWR model, the ArcGIS10.5 and Kriging interpolation method are used to show the influence of building density [5], plot ratio and greening rate on residential land price in Qingdao through graphs. The results are as follows:

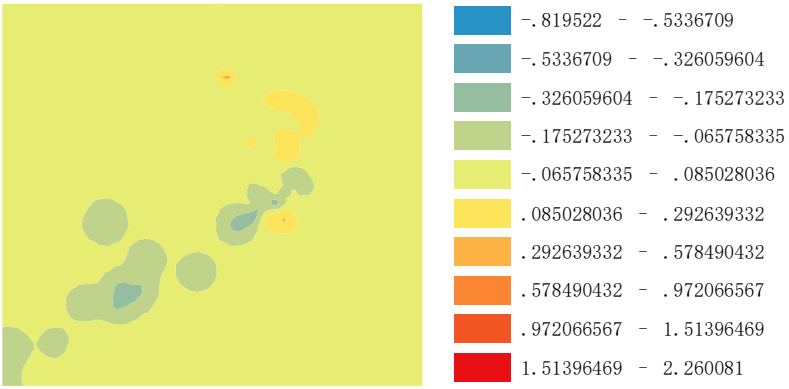

Fig. 5. The Influence of Building Density on Residential Land Price in Qingdao

As can be seen from Fig.5, the regression coefficient of building density is between -0.175273233 and 2.92639332, and the sample points of most regression coefficients are negative, indicating that the greater the building density, the lower the residential land price. This may be due to the continuous improvement of people's living standards, the continuous improvement of housing requirements, and the expectation to buy houses with low building density.

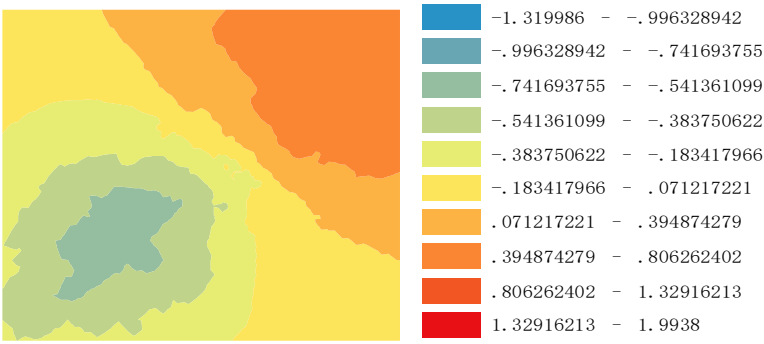

Fig. 6. The Influence of Greening Rate on Residential Land Price in Qingdao

As can be seen from Fig.6, the regression coefficient of greening rate is mostly positive, indicating that the higher the greening rate is, the higher the residential land price.

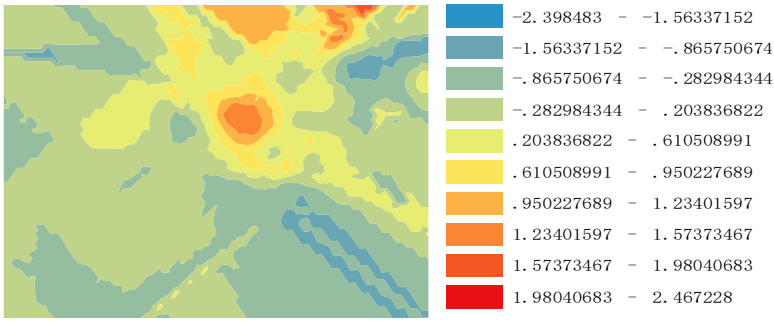

Fig. 7. The Influence of Plot Ratio on Residential Land Price in Qingdao

It can be seen from Fig.7 that most of the regression coefficients of plot ratio are negative, indicating that plot ratio is inversely proportional to residential land price, and the higher the plot ratio, the lower the residential land price. The regression coefficient of some areas is positive, mainly in the vicinity of Jimo City. It may be because Jimo city's economic development level lags behind that of other areas in Qingdao. In the past, it was mostly bungalows with low floor area ratio. But in general, the residential land price in Qingdao is inversely proportional to the plot ratio.

4 Conclusions

(1) Residential land price in Qingdao is subject to normal distribution, which can be analyzed by Kriging interpolation method.

(2) By analyzing the spatial trend of residential land price in Qingdao, it is found that the residential land price in Qingdao presents an inverted U-shape in both longitude and dimension directions. In general, the land price in the city center is the highest and

gradually decreases around the city. From south to north, the land price shows a trend from low to high and then lower; from west to east, the land price changes from low to high and then gradually decreases. But on the whole, the land price in the east is higher than that in the west, and the land price in the coastal area is higher than that in the inland area.

(3) The spatial autocorrelation analysis of residential land prices in Qingdao shows that the residential land prices in Qingdao show spatial agglomeration, but there are certain differences in local regional correlation. The residential land prices are relatively high around the central coastal high-priced areas, and gradually lower around the inland low-priced areas. In the northern district of the city, some low land price areas are distributed with high and low land price areas, and the correlation of other areas is not significant.

(4) According to the GWR model combined with Kriging interpolation method, the higher the building density, the lower the residential land price. The higher the greening rate is, the higher the residential land price is. The higher the plot ratio, the lower the residential land price.

(5) Due to the limited academic level, the paper did not reach the expected depth, the number of influence factors selected is relatively small. In the future, more impact factors can be adopted, and the characteristic price model and GWR model can both be used for comparative analysis to verify the consistency of the conclusions. Meanwhile, this method can be used to analyze the land price of other cities.

References

1. Xu Xiaohui. Research on Spatial differentiation of residential land price in Shangrao City based on GWR model. Jiangxi Normal University, 2014.
2. Wu Zhilong, Wu Wei, Yu Jinxiang, et al. Spatial and temporal evolution of aquaculture economic efficiency and its influencing factors in Poyang Lake Basin: Based on SBM-XTTobit-GWR model [J/OL]. Resources and Environment in the Yangtze Basin, 1-19[2024-10-17].
3. Liu Ming, LIU Xingzhong, Yang Xing. Downscaling of summer GPM precipitation fusion in Shaanxi Province based on GWR [J]. Journal of Sichuan Normal University (Natural Science Edition), 2024, 47 (06): 786-793.
4. Chen Fei, Chen Zhenjie, Li Feixue, et al. Urban land price spatial-temporal Stacking-GWR model [J]. Geography and Geo-Information Science, 2024, 40 (05): 1-10.
5. Shibeshi A,Gebreabe T S ,Tiruneh A , et al. Integrated municipal solid waste management using ArcGIS tools: A case of akaki-kality sub-city, addis ababa, ethiopia [J]. Environmental Science and Pollution Research, 2024, (prepublish): 1-25.
6. Bagheri B, Shaykh-Baygloo R. Spatial analysis of urban smart growth and its effects on housing price: The case of Isfahan, Iran[J]. Sustainable Cities and Society, 2021, 68(3):102769.