WEP Warwick Evans Publishing

International Journal of Global Economics and Management

ISSN: 3005-9690 (Print), ISSN: 3005-8090 (Online) | Volume 2, Number 1, Year 2024
DOI: https://doi.org/10.62051/ijgem.v2n2.09
Journal homepage: https://wepub.org/index.php/IJGEM/index

Research on Urban Land Suitability Evaluation Based on GIS—A Case Study of Xi'an City

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ABSTRACT

The evaluation of urban land suitability plays a crucial role in urban planning and land management. Taking Xi'an City as a case study, this research, based on ArcGIS software, conducted an in-depth study and evaluation of urban land suitability by comprehensively considering factors such as terrain, land use status, and DEM elevation data. By collecting and analyzing a large amount of spatial data, a set of urban land suitability evaluation models was established. With the functionality of ArcGIS software, spatial analysis and data processing were carried out to generate spatial distribution maps of urban land suitability. The research results indicate that land suitability is influenced by various factors, including terrain features, land use status, and elevation. Therefore, when formulating urban planning and land use policies, it is essential to consider these factors comprehensively to promote sustainable urban development and rational resource utilization. In future urban development, it is necessary to combine the influencing factors of urban land to develop more scientifically sound urban planning, aiming to achieve optimized spatial layout of cities and efficient resource utilization.

KEYWORDS

GIS; Translation: Urban Land Suitability Evaluation; Xi'an

1. INTRODUCTION

1.1. Research Background

Land is the basis for the survival and development of human society, and is an important factor restricting the social and economic development. The report of the 19th National Congress of the Communist Party of China proposed to unify all the responsibilities of territorial space use control and ecological protection and restoration, and the construction of territorial space development and protection system urban land suitability evaluation is one of the important contents of urban planning and land use [1]. With the acceleration of China's urbanization process and the increasing tension of land resources, it is urgent to make rational use of urban land resources and realize the realization of sustainable urban development. China has a large total amount of land resources, small per capita possession, obvious defects in resource endowment, extensive resource utilization, and distorted resource allocation [2]. Land suitability evaluation refers to the rating [3] of a certain piece of land for the suitability and suitability of a specific type of land use mode. The acceleration of urbanization process makes urban planning and land management face new challenges. Finding a balance between urban expansion and limited resources has become an important topic of urban development. As a

scientific method, urban land suitability evaluation can help decision makers to choose appropriate land use in the process of urban planning and land use, improve the efficiency of land use, reduce resource waste and promote sustainable urban development.

This study takes Xi'an City as an example to explore the adaptability and sustainable development potential of the city's land. As an important city in the western region of China, Xi'an plays a key role in promoting economic growth and social development. However, along with urban growth comes the limitations of land resources and the irrationality of land use. Facing rapid urbanization and limited land resources, assessing the adaptability level of land in Xi'an City, proposing corresponding improvement measures, is of great significance for achieving sustainable urban development. This paper, based on ArcGIS 10.8 software, uses Xi'an City as a case study, utilizing Xi'an City GDEMV3 30M resolution digital elevation data, 1:1 million national basic geographic data, and Xi'an City GLOBELAND 30 land use type data. By employing the multi-factor overlay analysis method, it constructs evaluation indicators affecting the urban land suitability of Xi'an City, determines the weights of each indicator using the Analytic Hierarchy Process (AHP), and completes the study on the suitability evaluation of urban land development in Xi'an City.

1.2. Research Area

Xi'an, abbreviated as "Gao", formerly known as Chang'an and Haojing, is located in the middle of the Guanzhong Plain, between 107°40' to 109°49' east longitude and 33°39' to 34°45' north latitude. It is the capital of Shaanxi Province, a sub-provincial city, a mega-city, and the core city of the Guanzhong Plain Urban Agglomeration. Xi'an is designated by the State Council as an important central city in western China, and a national key scientific research, education, and industrial base. The total area of Xi'an is 10,108 square kilometers, with a permanent population of 12.9959 million as of the end of 2022. In 2022, the city's gross domestic product (GDP) reached 1,148.651 billion yuan, with a per capita GDP of 88,806 yuan. Located in the middle of the Guanzhong Plain, Xi'an is bordered to the north by the Wei River and to the south by the Qinling Mountains. The terrain is higher in the southeast and lower in the northwest, with an average elevation of around 410 meters.Refer with: Fig. 1

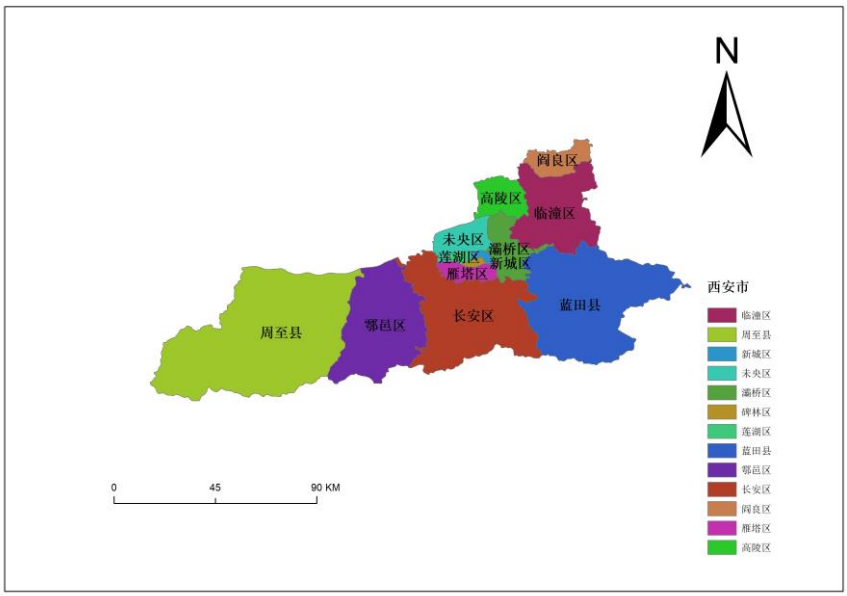

Figure 1. Location map of Xi'an city

1.3. Research Methods

Land suitability evaluation is to assess whether land is suitable and suitable for a certain use. It is the basic basis for making land use decisions and scientific preparation of land use planning [4]. By selecting the influence factors related to land suitability, the evaluation model is constructed to evaluate the suitability of urban land development in Xi'an city.

1.3.1. Analytic Hierarchy Process.

The Analytic Hierarchy Process (AHP) is a method for multi-criterion decision making. It breaks down the decision problem into a hierarchical structure, and then uses expert judgment and mathematical calculation to determine the weight of each level, and finally obtains the best decision scheme. Its principle is to make choices for multiple alternatives, determine the most suitable scheme and form the factors of each scheme into several levels, starting from the second layer, the second layer of the factors determine the importance of the first layer, and then get the weight of the layer in the next layer, then compare the next layer, and so on until the determination of all factors weight [5].

1.3.2. Multi-factor Comprehensive Weight Overlay Analysis Method

Selected evaluation index and establish the evaluation index system, combined with the actual situation of the evaluation area of individual index score, and then according to the importance of the evaluation index, the most key step is the evaluation of each individual evaluation index score weighted sum, get the suitability of each evaluation unit, and then according to the following grading evaluation work [6].Refer with: Eq. 1

$$V = \sum_{i=1}^{n} (B_i = W_i) \tag{1}$$

(V)represents the suitability evaluation value for a specific land use type; (B_i) represents the evaluation value of the i-th evaluation indicator; (W_i) represents the weight of the i-th evaluation indicator determined through the Analytic Hierarchy Process (AHP);（n）represents the number of evaluation indicators in the evaluation indicator system.

1.4. Establishment of Evaluation Indicator System and Determination of Weight

The selection of evaluation indicators should follow principles such as ecological nature, comprehensiveness, dominant factors, and suitability to local conditions. Due to differences in regional characteristics and types, the indicator system of different research areas will have different emphases. In addition, some regions in special geographical locations will focus on specific factors as needed. The division of levels for each factor is essentially determining the suitability coefficient of each level of the factor for the land use through scoring. Based on relevant literature and the "Guidelines for the Evaluation of Resource and Environmental Carrying Capacity and Land Space Development Suitability (Trial)" issued by the Ministry of Natural Resources, the evaluation system for urban land suitability in Xi'an City is established, refer with: Table 1.

Table 1. Xi'an City Urban Land Adaptability Evaluation Index

Primary Indicators	Secondary Indicators	Weight	Ⅴ	Ⅳ	Ⅲ	Ⅱ	Ⅰ
DEM Data	Elevation	0.05	<500m	500-100m	1000-1500m	1500-2000m	>2000m
	Slope	0.15	<5°	5-10°	10-15°	15-20°	>20°
Basic Geographic Information Data	Water System	0.15	>100m			0-100m	<0m
	Roads	0.15	<1000m	1000-2000m	2000-3000m		>3000m
	Residential Areas	0.2	<500m	500-1000m	1000-2000m		>2000m
	HCA	0.2	>500m		200-500m	0-200m	<0m
Land Use Data	Current Land Use	0.1	Construction Land		Farmland	Woodland	Waters

2. RESULTS ANALYSIS AND EVALUATION

2.1. Single-factor Evaluation Results

2.1.1. Terrain Factor Evaluation Results.

As the natural factor with the greatest influence on the land use change, the topographic factor directly affects the mode and trend of the land use change [9]. By processing the 30-meter resolution GDEMV3 digital elevation data of Xi'an city and reclassifying it based on relevant evaluation indicators, Figure 2 shows the elevation factor scoring results, and Figure 3 shows the slope factor scoring results. It can be observed that in the urban land use area of Xi'an, the areas more affected by the elevation factor and slope factor are mainly located in the areas with lower terrain and lower slope.

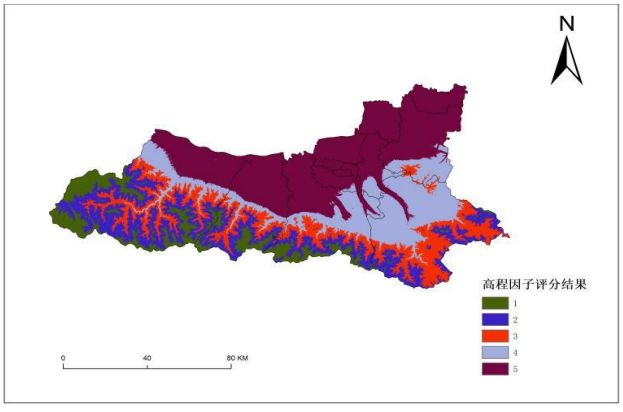

Figure 2. Elevation Factor Score Results Fig

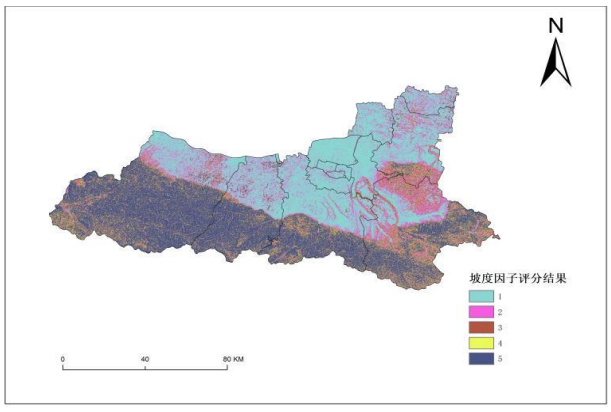

Figure 3. Results Plot Of The Slope Factor Score

2.1.2. Residential Area Factor Evaluation Results.

Through the data extraction of 1:1 million national basic geographic data provided by the national geographic information resource catalog service, the basic data of residents is processed, and reclassified according to the relevant evaluation indicators. Figure 4 shows the scoring results of

resident local factors. It can be clearly observed from the figure that the urban land use in Xi'an is significantly influenced by the resident land factors.

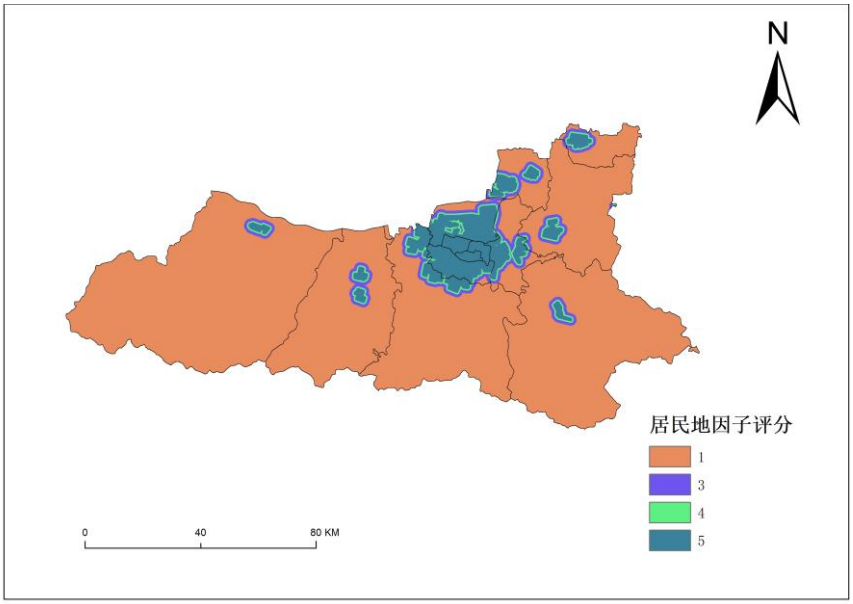

Figure 4. Resident local factor score chart

2.1.3. Road Factor Evaluation Results.

Through the data extraction of 1:1 million national basic geographic data provided by the national geographic information resource catalog service, the basic road geographic data is processed, and reclassified according to the relevant evaluation indicators. Figure 5 shows the scoring results of road factors. It can be clearly observed from the figure that Xi'an city has developed urban transportation, good accessibility, and great potential for land development.

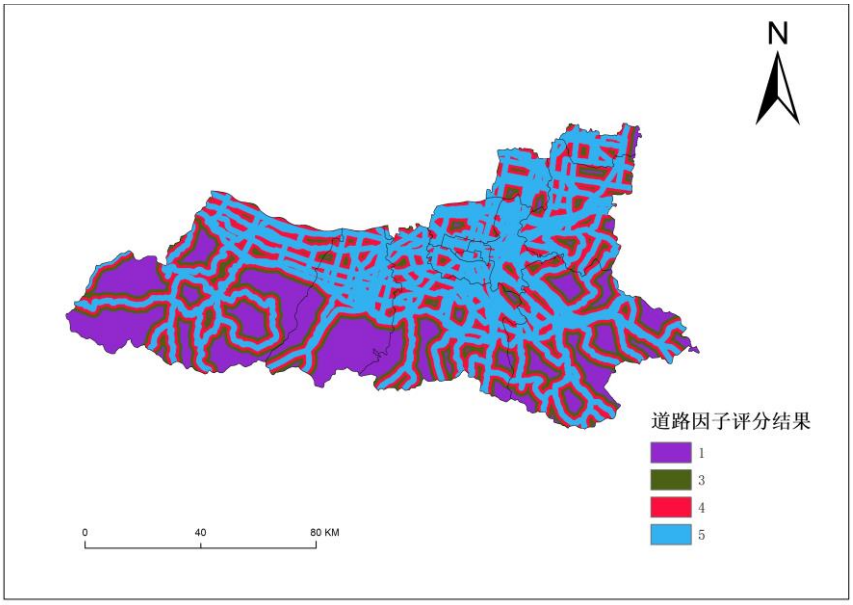

Figure 5. Road factor score plot

2.1.4. Non-development Factor Evaluation Results.

Non-development factors refer to all kinds of protected areas established according to law, including nature reserves, world cultural heritages, scenic spots, forest parks and geoparks, which are the most important and critical ecological environment protection areas in China. The development direction of the prohibited development zone is to implement compulsory protection of the ecological environment according to laws and regulations, strictly control the interference caused by human factors to the ecological nature, and prohibit all development activities that do not conform to its functional orientation [10]. Through the geographic information resources directory service 1:1 million national basic geographic data for data extraction, xi'an ban development factor based data including drainage data, ecological reserve data, according to the relevant evaluation index and reclassification, the results are shown in figure 6 ban development factor score results, it can be seen that the xi ban development area mainly for the qinling mountains and other national planning of nature reserves, due to the particularity and importance of the protection area of urban land development ban development factor, mainly concentrated on the reserve.

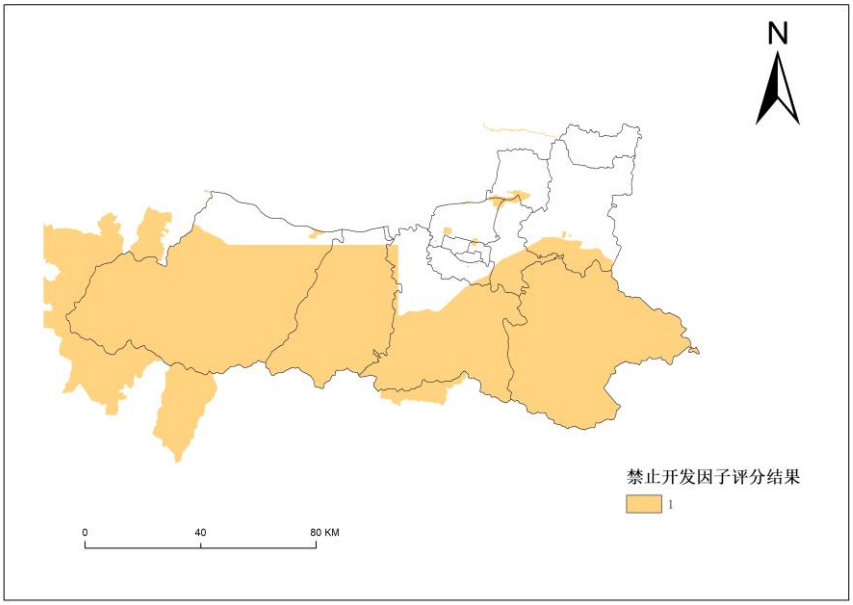

Figure 6. Development of factor score plots is prohibited

2.1.5. Current Land Use Status Factor Evaluation Results.

By processing the land use data of Xi 'an city provided by GLOBELAND 30, and reclassifying according to relevant evaluation indicators, the results are shown in the scoring results of Figure7, it can be seen that the land use status of Xi' an city is closely related to its residual factors and has strong coupling.

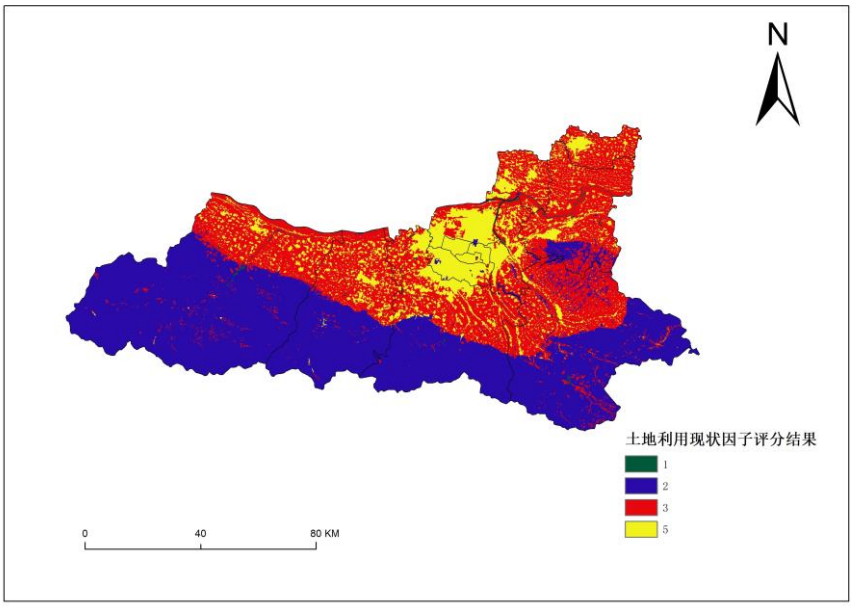

Figure 7. Score chart of land use status factor

2.2. Comprehensive Evaluation Results

The elevation factor, slope factor, road factor, residential land factor, forbidden development factor and land use status factor are analyzed, and the weighted sum of related factors is calculated. The evaluation results are shown in Figure 8 of land suitability evaluation results, in which 1 to 5 represent unsuitable, low suitability, moderate suitability, medium-high suitability and high suitability, respectively. Among these regions, the region with 1 cent represents the largest unsuitable area, mainly distributed in the Qinling Mountains, while the region with 5 represents the most suitable area, most of which are located in the urban center of Xi'an.

In order to verify the rationality of the experimental results, through the xi 'an 202030M remote sensing data as shown in figure 9 and figure 10 land adaptability evaluation results can be seen can be obvious, xi' an land suitability evaluation analysis of the results consistent with the existing land use pattern, which proves the scientific nature and accuracy of this study.

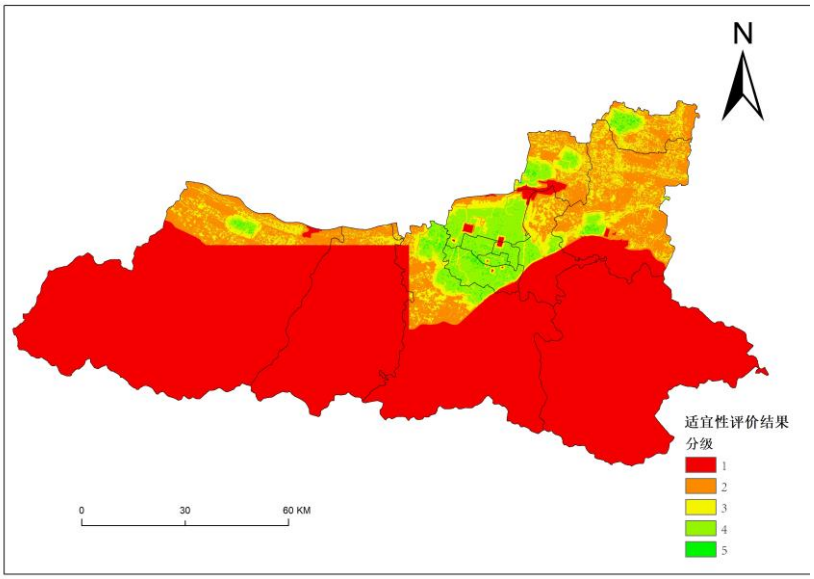

Figure 9. The results of land suitability evaluation Fig

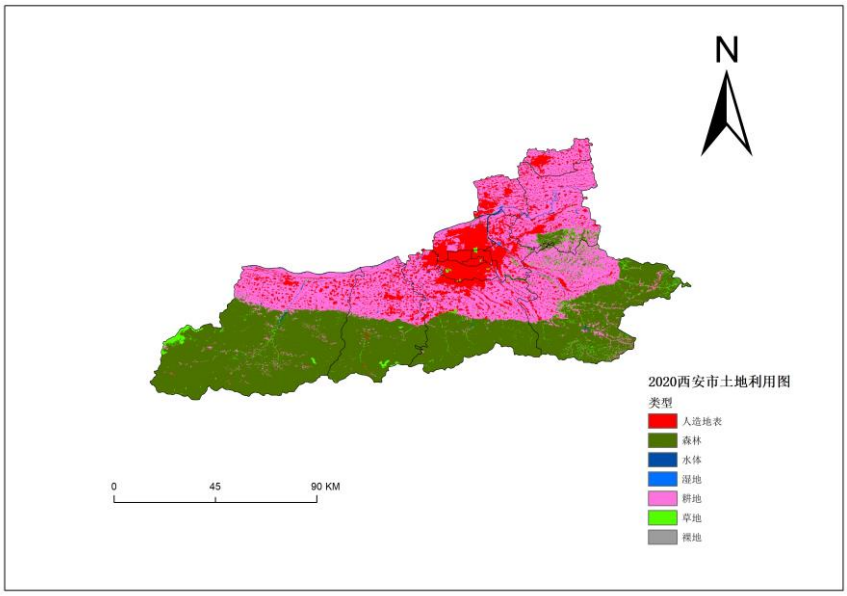

Figure 10. Xi'an2020 land use map

3. SUMMARY

This study takes Xi'an City as a case study and utilizes resources such as Xi'an City GDEMV3 30M resolution digital elevation data, 1:1 million national basic geographic data, and Xi'an City GLOBELAND 30 land use type data in ArcGIS 10.8 software. The study employs a multi-factor overlay analysis method to construct an indicator system that influences the evaluation of urban land suitability in Xi'an City. Based on this, the Analytic Hierarchy Process (AHP) is used to determine the weights of each indicator, completing the research on the suitability evaluation of urban land development in Xi'an City. The following conclusions were drawn:1.The urban land use in Xi'an City is mainly influenced by elevation and slope factors in areas with lower elevation and smaller slopes. The residential area factor has a significant impact on urban land use, indicating a greater potential for land development with good accessibility. Non-development areas are mainly located in the Qinling Mountains, where these areas are significantly affected by non-development factors.2.By overlaying the administrative divisions of Xi'an City with the results of land development suitability, it was found that the most suitable areas are mainly concentrated in the main urban area of Xi'an City, while the least suitable areas are located in the Qinling Nature Reserve. The verification results show that the spatial distribution of land use in Xi'an City in 2020 is highly consistent with the analysis results of land development suitability, verifying the rationality and feasibility of the urban land development suitability indicators constructed in this study.This study aims to explore the adaptability and sustainable development potential of land in Xi'an City. As an important city in western China, Xi'an City faces rapid urbanization and limited land resources. Therefore, evaluating the level of land adaptability and proposing improvement measures are crucial for achieving sustainable urban development. The goal of this study is to enhance the scientific accuracy of urban planning and land use and promote the sustainable development of Xi'an City. Additionally, the methods and conclusions of this study can provide valuable insights and references for the land suitability evaluation of other cities.

REFERENCES

[1] Xi Jinping. Securing a decisive victory in building a moderately prosperous society in all respects and achieving the great victory of socialism with Chinese characteristics for a New Era [N]. People's Daily, 2017-October 28 (001).

[2] Wang Ziyao. Progress in land suitability evaluation in China [J]. Agriculture and Technology, 2020,40(04):36-41. DOI:10.19754/j.nyyjs. 20200229010.

[3] Shi Longyu, Huang Yunfeng, Cui Shenghui, etc. Evaluation method and application of land suitability in semi-urbanized areas -Take Jimei District of Xiamen city as an example [J]. Land Science of China, 2010,24(05):53-57+63. DOI:10.13708/j.cnki.cn11-2640.2010.05.002.

[4] Jiang Jiajia, Shao Jing an, Tan Shaojun, etc. Evaluation of ecological suitability for the development and construction of low hills and gentle slopes in Liangjiang New Area, Chongqing [J]. Geographic Research, 2019,38 (06): 1403-1419.

[5] Shi Longyu, Huang Yunfeng, Cui Shenghui, etc. Evaluation method and application of land suitability in semi-urbanized areas - Take Jimei District of Xiamen city as an example [J]. Land Science of China, 2010,24(05):53-57+63.DOI: 10.13708/j.cnki.cn11-2640.2010.05.002.

[6] Jiang Yingchao. Evaluation of urban land suitability in Weihai Huancui District based on GIS [J]. Beijing Surveying and Mapping, 2018,32(05): 594-598.DOI:10.19580/j.cnki.1007-3000.2018.05.022.

[7] Yang Yi, Zhao Nanqi, Li Guicai. Evaluation of urban land [J]. Research on Modern Cities, 2015 (04): 91-9

[8] Huang Xiaofang. Application of GIS in the evaluation of ecological suitability of urban land use -Take Pudong New Area of Shanghai as an example [J]. Science, Technology and Engineering, 2011,11 (31): 7841-7846.

[9] Wang Shidong, Wu Chao. Evaluation of the influence degree of land use change based on the improvement index and method [J]. Chinese Journal of Eco-Agriculture, 2018,26(03):442-452. DOI:10.13930/j.cnki.cjea. 170593.

[10] Xiao Haiping, Huang Jingbo. Comprehensive evaluation of ecotourism environmental quality in the prohibited Development Zone [J]. Resource Development and Market, 2011,27 (06): 551-554.