

Analysis on Land-use Expansion in the Process of Urbanization in Shiyang River Basin

Hui ZHANG ^{1,2,a}, Zhiqiang ZHANG ^{3,b}

¹ Geography and Environment College, Northwest Normal University, Lanzhou, Gansu

² Lanzhou University of Arts and Science, Lanzhou, Gansu

³ Scientific Information Center for Resources and Environment, Lanzhou, Gansu

^azhang_h1009@163.com, ^bzhangzq@lzb.ac.cn

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Abstract. The Shiyang River Basin is one of the key research areas of sustainable economic and social development in the river basins of China. In order to figure out the mechanism of land-use expansion in the process of urbanization of Shiyang River Basin, the paper intends to carry out the evaluation of land-use expansion because of urbanization from the perspectives of social economy, regional transportation and ecological environment. By taking advantage of the land suitability evaluation method, it makes out the spatial framework of possible areas for urban expansion so as to provide suggestions for the further coordinative development of urbanization in the basin area as well as of the ecological zones.

Introduction

Urban expansion is the inevitable trend of regional development, making lots of farmlands converted into lands for urban and rural construction. China's eastern coastal areas have witnessed the urbanization over the 30 years of reform and opening up while taking the suitability of space division referring to both the development and the protection into the consideration^[1-3] and scholars have conducted a number of researches on spacial expansion of these areas. However, the western areas of China have seldom been covered in such researches^[7] because the selection of ecological protection factors varies by region^[5-6]. The Shiyang River Basin belongs to the arid area of northwest China, which differs greatly from China's eastern coastal areas. Only the traffic network is considered in most of the researches on urban expansion in recent years, without any consideration of factors like terrain and gradient.

Because the western areas of China are featured by complex terrain and harsh natural environment, the paper adopts the improved methods of vector data spatial analysis and raster data spatial analysis to study the stimulation image factors of urban expansion by taking the GRID as the evaluation unit with the support of ArcGIS, finding out the regions with high possibilities of spacial distribution for urban expansion in the Shiyang River Basin so as to provide the scientific basis for the structure and layout adjustments of regional urban space, the urban planning and so forth.

Data Processing and Methods Described

The Shiyang River Basin lies in the eastern section of Hexi Corridor and at the foot of the northern slope of Qilian Mountains, located between 101°22' and 104°16' in east longitude and between 36°29' and 39°27' in north latitude. The essential data is on one hand mainly from the Environmental and Ecological Science Data Center for West China, Committee of National Natural Science Foundation of China (<http://westdc.westgis.ac.cn>) and on the other hand from the land use data in 2012 obtained from the Landast TM Images while the economic data is from the social and economic statistics of various counties and districts in 2012.

The evaluation factors can be divided into regional homogeneous factors and spacial diffusion ones. The homogeneous factors take the administrative divisions and natural elements as the unit to

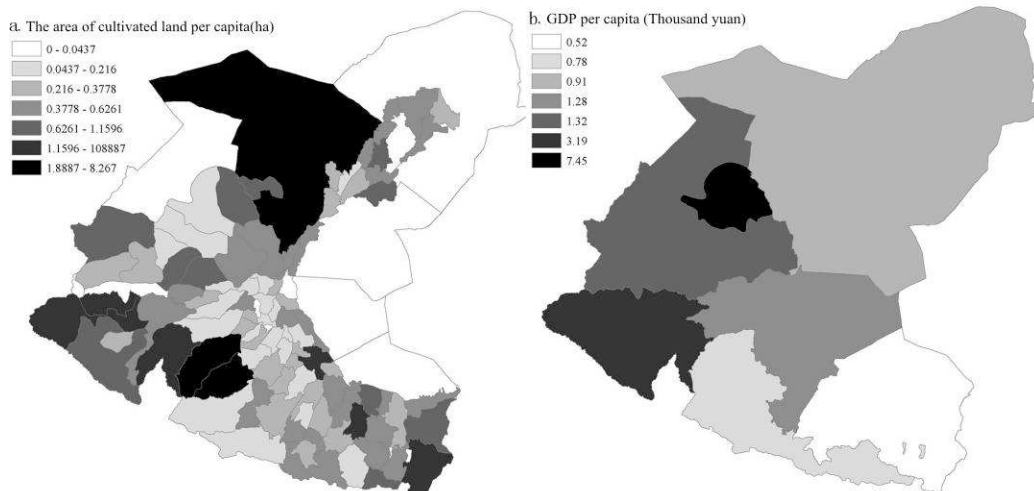
generate the layers en plaque, i.e. per-capita farmland and GDP while the diffusion factors are divided into vector diffusion factors and raster ones, which can be further divided into homogeneous diffusion and conditional one. The vector diffusion factors can be used to measure the influence of counties and districts in the basin center while the conditional diffusion factors can be used to measure the transportation accessibility to the provincial capital and the homogeneous diffusion factors can be used to calculate the distance from water systems and the industrial enterprise agglomeration.

The economic factors include the area of farmland per capita (on the township level), GDP per capita (on the county level), the industrial enterprise agglomeration and the distance from water systems (including main rivers, reservoirs and lakes); the locational conditions cover the influence of counties and districts in the center and the provincial capital transportation accessibility; the ecological constraints include DEM (gradient+relief amplitude), desertification system (forest desert system with shrub and grass), precipitation and Normalized Difference Vegetation Index (NDVI).

Analysis of Results

Economic Factors. According to the social and economic statistics of counties and districts of Shiyang River Basin in 2012, the impact factors of farmland per capita are generated with the villages and towns as the basic unit (Figure 1a). Based on 2012 Gansu Development Almanac, the impact factors of GDP per capita are generated with the counties in Shiyang River Basin as the basic unit by collecting the population data and GDP of prefectures and counties (Figure 1b). Because being close to the water source needs taking into consideration in urban construction, especially in arid areas, the gradient stacking map of the impact factors of rivers and reservoirs is made out by adopting the Minimum Euclidean Distance Algorithm (Figure 1c). Mineral resources play a decisive role in the formation of a city so that the paper selects the grounding plaques of industrial and mining areas from the construction land in the 2012 Shiyang River Basin Land Use Map to represent the industries and enterprises. By adopting the same method used in Figure 2c, the gradient map of the impact factors of the industrial enterprise agglomeration is made out (Figure 1d).

Locational Conditions. The paper intends to measure the influence of counties and districts in the basin center, the superimposed landform and the traffic network. According to the spacial analysis method of vector data, it measures the influence of counties and districts in the basin center on other areas of the basin by using the gravity model (Figure 2a). The figure shows that the influence of counties and districts in the basin center gradually becomes smaller and smaller with the range of land becomes farther and farther from the roads.



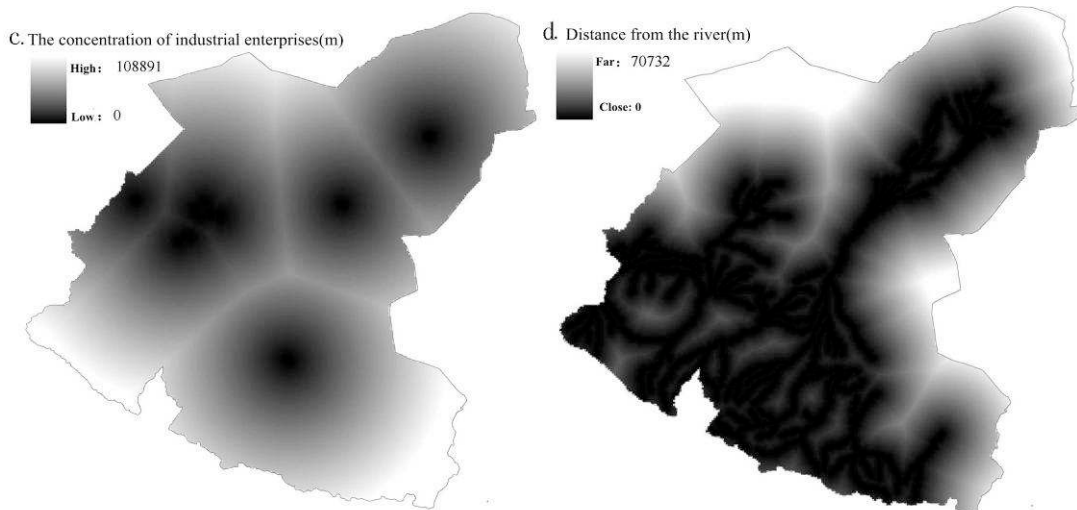


Figure 1 The Economic Impact Factors

By adopting the main roads, railways and topographic data from National Fundamental Geographic Information System 1:4,000,000 nationwide database, the paper chooses the parts belonging to Gansu Province and combines them with terrains, land and water transportation conditions of Shiyang River Basin, together with the DEM of Gansu Province, so as to make out the Lanzhou Cost Raster, which can be used to measure the transportation accessibility from Lanzhou to the whole basin, i.e. the transportation accessibility to the provincial capital, as is seen in Figure 2b. The figure tells that the closer the cities in the basin are to the road traffic system in high levels, the more flat the land is and the better the transportation accessibility is. The good transportation accessibility to Lanzhou indicates that the various regions in the whole basin have the locational advantage of the provincial capital.

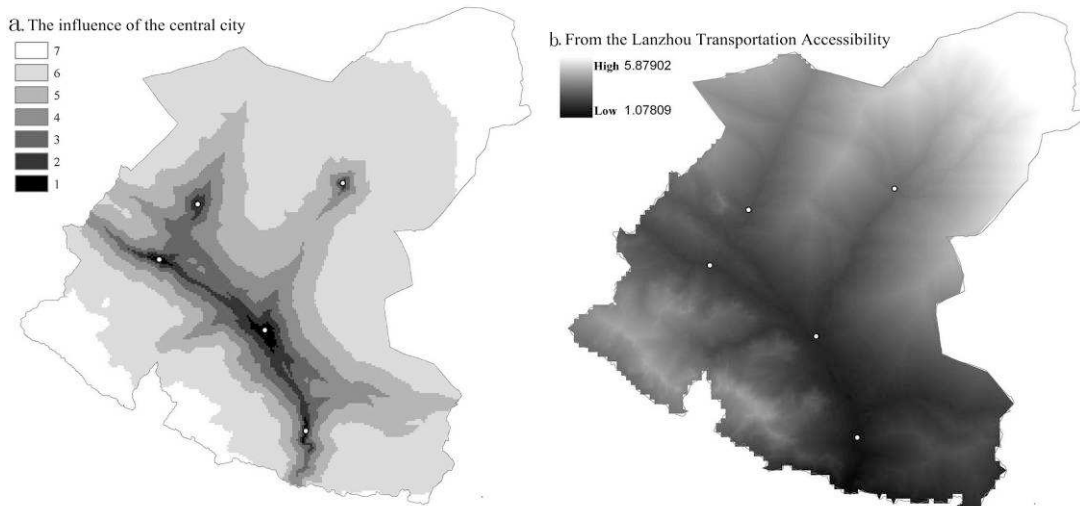


Figure 2 The Impact Factors of Locational Conditions

Ecological Constraints. DEM is obtained from SRTM website by cutting according to the administrative boundary of the basin (Figure 3a). The average annual precipitation chart is defined as the Average Precipitation Raster in 1km×1km Basin (Figure 3b) by using the Kriging Interpolation on the basis of years of precipitation data collected by seven meteorological stations in or around Shiyang River Basin. The value of ecosystem services in the basin is the regional homogeneous factors. In accordance with the data of land types in 2012, the paper picks up the elements of desert types and stratifies them according to the severity of desertification and then makes out the Desertification Severity Type Map for Farmland. By combining with the farmland distribution data from the land type map, the basin farmland protection system comes out, which indicates that contrary to desert type, the lower the value of farmland system, the more suitable for the land to be used for urban construction. The picked-up data of forested land and grassland is superimposed into the ecological

constraints system on the same basis of the classification of desertification severity (Figure 3c). The 2012 basin NDVI is measured by the method of maximum synthesis with the data from Free VGT website, which covers 12 months of 2012 with 3 terms in each month (Figure 3d).

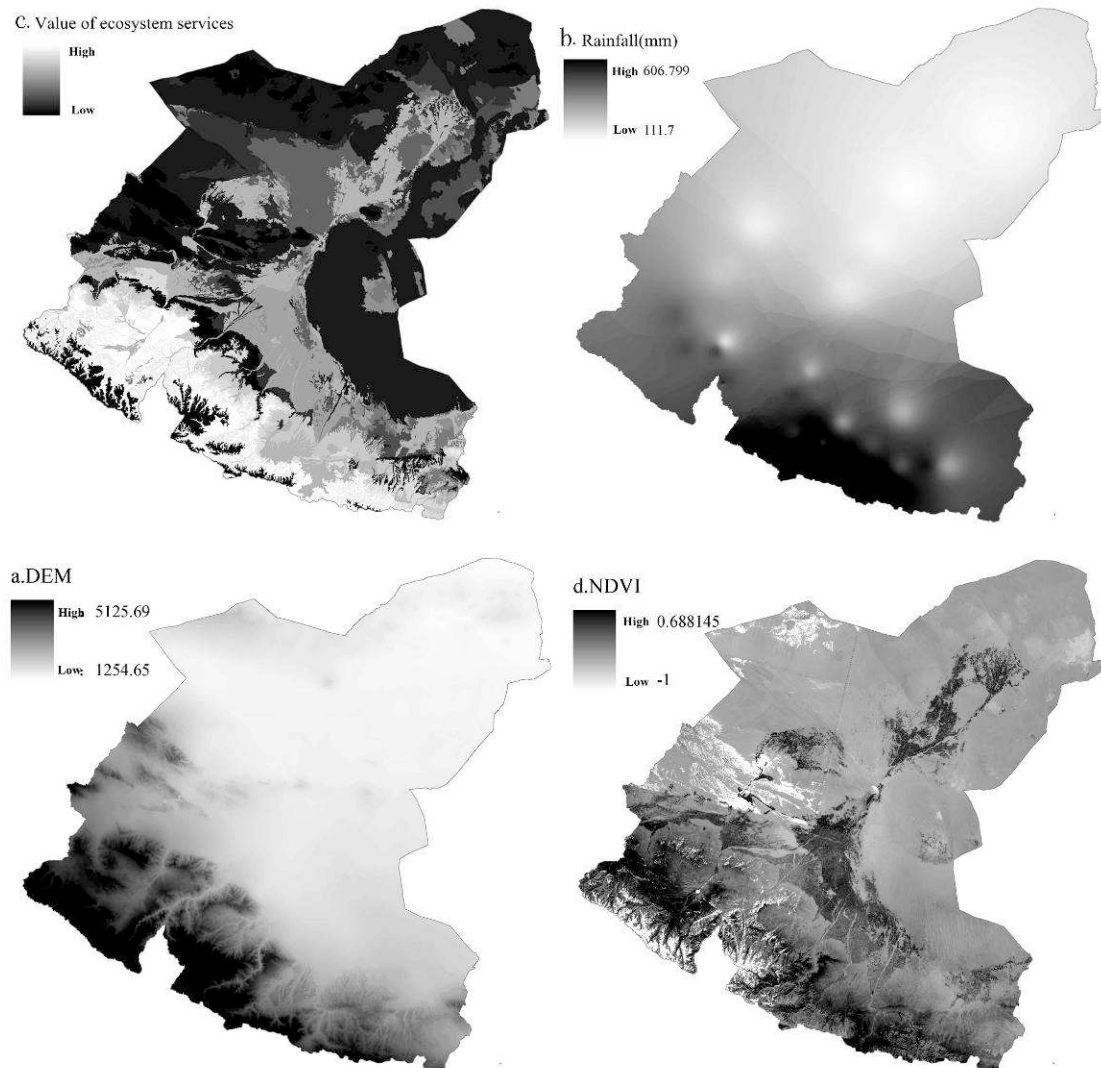


Figure 3 The Ecological Constraints Factors

Analysis on Possible Areas for Urban Expansion. The following factor weights are determined by combining the analytic hierarchy process (AHP) with the expert-grading model (Table 1). The Distribution Map of Possible Areas for Urban Expansion in Shiyang River Basin (Figure 4) is measured by superimposing on the GIS platform.

Table 1 Evaluation Factors' Weights of Urban Expansion in the Basin

System Level	Index Level	Weight
Economic Factors	The area of farmland per capita	0.0892
	GDP per capita	0.0921
	The industrial enterprise agglomeration	0.0934
	The distance from rivers (water system)	0.1079
Locational Conditions	The influence of center cities	0.1264
	The transportation accessibility to Lanzhou	0.1122
Ecological Constraints	DEM	0.1021
	precipitation	0.0956
	The value of ecological services	0.0927
	NDVI	0.0884

The table shows that the possibility of urban expansion in the basin is becoming smaller and smaller as the distance from the main roads increases under the condition of taking basin farmland protection and ecological constraints into full consideration. The water conservation area in the south of Qilian Mountains is impacted by the terrain, gradient, forested land and grassland so that the possibility for urban expansion there is small. The oasis ecological function zone in the middle part is characterized with developed road traffic, making the possibility the largest, where however most basic farmlands cover because of the adequate irrigation water. As a result, the possible expansion values are distributed according to the farmland level from low to high on one hand and to the road level from high to low on the other hand. The interaction zone between desert and oasis in the north is flat so that the possible values gradually decrease as the distance from reservoirs or rivers increases. Because the four counties (except for Minqin County) in the basin are all located in the oasis zone in the middle part and various levels of road network there are complex, their possible values for urban expansion are much higher than that of the other two regions. Moreover, these possible values are distributed in the star diffusion pattern along the road networks.

Conclusion

Based on the basic data and economic data of Shiyang River Basin, the paper has measured the impact factors of locational conditions in the basin, i.e. the influence of counties and districts in the basin center and regional transportation accessibility, by taking advantage of the urban land-use suitability evaluation method with the combination of basin farmland protection and ecological constraints, including economic impact factors and ecological environment impact factors. The weights are measured by adopting the analytic hierarchy process (AHP). The research results about the possibilities for urban expansion and the spacial distribution of the suitability of various villages and towns indicate that the regions with high possibilities and villages and towns with good suitabilities are mainly distributed in the oasis ecological function zone in the middle part, along the G30 Lianhuo Highway and 312 National Highway. The regions with the highest possibility are in the administrative region of Liangzhou District, Wuwei City and around the county seat of Yongchang County.

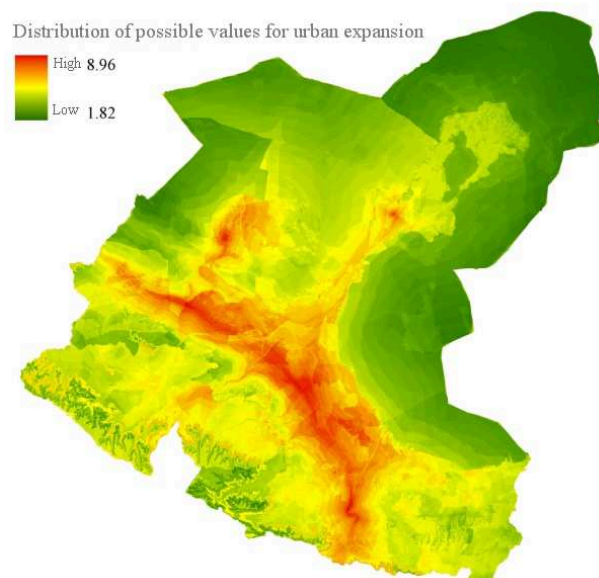


Figure 4 The Distribution Map of Possible Areas for Urban Expansion in Shiyang River Basin

The paper analyzes several issues like economic and social development, the utilization of transportation resources, ecological environment construction and so forth in a systematical way according to the history and present situation of the exploration and utilization of land and water resources in the basin area. Consequently, the areas with suitabilities for urban expansion have been

figured out so as to guide the sustainable development in the basin and provide references for development planning.

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