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A study on the dynamic evaluation of urbanization development quality: An example of 9 counties in Lishui City, Zhejiang Province

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ABSTRACT

As an important indicator to measure the economic development and modern civilization of a country or region, the evaluation of urbanization development quality is a complex systematic project, which is helpful to clarify the strengths and weaknesses and regulate and guide the development strategies. Based on hierarchical analysis, geographically weighted regression analysis and cluster analysis, this paper takes Lishui City, Zhejiang Province as an example and selects 1 primary indicator, 4 secondary indicators and 17 tertiary indicators to construct an urbanization development evaluation index system and make an objective evaluation of the development status. The results show that: the level of urbanization development in Lishui City is relatively backward in the province, but the development trend is good; in terms of spatial correlation, the development of 9 counties and districts is relatively close, among which Qingtian County plays a key role in the development of urbanization in Lishui City; in terms of cluster analysis, the city's 9 counties and districts can be divided into "agglomeration enhancement type" and "coordination In terms of cluster analysis, the city's 9 counties and districts can be divided into three major types." Cluster Enhancement Type", "Coordination Promotion Type" and "Weak Development Type". In addition, countermeasures are proposed according to the development status to provide some reference for the future development of Lishui City and similar cities.

KEYWORDS

Lishui city; Urbanization development; Cluster analysis; Quality evaluation; Optimization and enhancement

1 Introduction

Promoting new-type urbanization is a powerful support for promoting coordinated regional development, an important grasp for expanding domestic demand and promoting industrial upgrading, and a necessary way to achieve modernization. In recent years, the level of total urbanization indicators in the world has been increasing, and it has gradually become one of the core points of development in various countries. After China's reform and opening up, the most important form of urbanization has been voluntary migration, where rural residents voluntarily go to cities for urban work, along with involuntary migration, in-

cluding land expropriation, environmental or climate change, etc., which has greatly advanced China's urbanization process under subtle influence, but has also generated many unavoidable governance problems (Li et al., 2016). Currently, cities are the core of socio-economic development, and the new development stage overlaps with the middle and late stages of China's urbanization, which urgently requires a strategic plan that is in line with the development characteristics of the times. In 2020, Xi Jinping listed improving the new urbanization strategy as one of the major issues in China's medium- and long-term economic and social development strategy. In March 2021, the main indicators of socio-economic development in the 14th Five-Year Plan clearly put forward the top-level design requirements for China's urbanization development - "the urbanization rate will increase from 60.6% to 65%". Therefore, it can be predicted that in the next five years, China's urbanization rate will still be in the rapid growth interval, and the urbanization construction will shift to the high-quality development stage, and continuously align with international standards and move to the leading position.

As China's industrialization and urbanization continue to accelerate, urban space is also expanding rapidly. In 2011, China's urban population exceeded the rural population for the first time, with an urbanization rate of 51.27%, while in 2019 China's urbanization rate exceeded 60% for the first time, higher than the world average standard of 55.3%, and is moving towards development and maturity, but there is a large gap with the 81.3% urbanization of developed countries. In the environment of the new economic normal and rural revitalization strategy, urbanization is not only an important initiative to expand domestic demand, but also assumes the heavy responsibility of boosting economic growth. In short, in the future, urbanization will remain the focus and highlight of China's development. Therefore, objectively evaluating the level of urbanization development indicators in each region of China, judging the development strengths and weaknesses, and summarizing the urbanization paths that can be used as reference, can provide a new direction of urbanization development for cities in China and the world to think about.

In recent years, Lishui City has broken the dual urban-rural household registration system, continuously optimized the layout and shape of urbanization, promoted regional synergy, urban-rural integration, "small county, big city" construction, and promoted the simultaneous development of new industrialization, informationization, urbanization and agricultural modernization, gradually constructing the "112" town system pattern of "one central city, ten small cities and twenty central towns", and taking the lead in the province and even the country to come out of a new ecological urbanization road with mountainous characteristics of people-oriented, group development, industry-city integration, ecological civilization and cultural heritage. Therefore, this paper innovatively uses hierarchical analysis, geographically weighted regression analysis and cluster analysis to establish a new type of urbanization development quality evaluation system from four levels: demographic, economic, environmental and social, taking the 2015-2019 urbanization development level of Lishui City, Zhejiang Province as an example, to summarize the characteristics and propose optimization suggestions through empirical analysis, which can provide some reference for the future urbanization development of Lishui City and cities of the same type.

2 Review of the literature

As an important indicator of a country or region's economic development and modern civilization (Li & Li, 2012), evaluating the quality of its development is a complex systemic pro-

ject involving demographic, economic, social and environmental aspects (Wang et al., 2013), and an effective evaluation can help clarify the strengths and weaknesses, and further standardize and guide the development strategies of each region. Therefore, many scholars have studied the development of urbanization around the world from different perspectives. Through reading a large amount of literature, this paper summarizes three main research perspectives.

The first perspective, by enhancing the degree of integration of new urbanization with other fields, delves into the development trend of urbanization characteristics from the perspective of single influencing factors. Chen (2018) used regression analysis and data envelopment analysis (DEA) methods, combined with urbanization quality evaluation and financial expenditure performance evaluation, which can provide support for the development of new urbanization supported by finance. Cui et al. (2015) attached importance to the development of regional ecological and environmental quality, established the ecological and environmental quality index (EQI) model to determine the ecological condition, and obtained two major influencing factors of meteorological conditions and industrial structure through regression analysis. Chen et al. (2015) used a double logit model, introduced time series variables of urbanization development, evolved into the parameter re-evaluation of Chenery model, and summarized the relationship pattern between urbanization and economic development, so as to provide a reference for realizing the leapfrog development of the economy.

In the second perspective, a correlation index evaluation model is established to test the level of urbanization development, point out the development deficiency and put forward opinions and suggestions. Shi et al. (2013) used the coordination degree of urbanization as an entry point to judge the four components of population urbanization, economic urbanization, land urbanization and social urbanization using TOPSIS and the coordination degree function method. Yang et al. (2020) captured the shortage of urbanization development, conducted factor analysis using SPSS software, established a new urbanization evaluation index system, and proposed four countermeasures to promote the development of industrial integration and so on. Based on a typical DEA model, Fang et al. (2018) innovatively proposed three sustainable urbanization benchmarking methods with their own focus of landing points to provide an efficiency perspective to examine more comprehensive and accurate performance scores to further guide sustainable urbanization performance.

The third perspective explores the extent of the impact of urbanization on different objects, such as environment and population, and builds statistical models to increase the dominant effect and diminish the negative contagion. Ketabchy et al. (2018) determined the level of urbanization development by detecting the survival factors of aquatic organisms and integrated unique hybrid methods such as SWMM and MINUHET models to simulate the survival status in real time and improve the river environment. Grilo et al. (2013) screened three different collection sites to assess the impact of urbanization process on organic matter (OM) deposition in a complex polluted tropical estuary, and summarized three main influencing factors based on judging the urbanization development trend. Yang et al. (2012) used existing literature, mathematical statistics, etc., to compare and analyze the urbanization process and the change of livestock pollution level in Songjiang, Shanghai, to emphasize the problems caused by livestock pollution to the environment and to propose suggestions for improvement.

Through literature review, it can be seen that there are three main trends in the research on urbanization evaluation at home and abroad:

(1) Most of the existing studies focus on the construction and upgrading of models, strengths and weaknesses and suggestions for countermeasures in the evaluation of urbanization quality, but there are fewer descriptions of comprehensive analysis of multiple urbanization indicators and the combination of qualitative and quantitative.

(2) Most existing studies are limited to local development contexts and policies, and there is a lack of systematic and comprehensive research directions and analyses of national strategic urbanization plans and new urbanization development patterns.

(3) Scholars' studies on urbanization evaluation mostly emphasize a single microscopic approach and are less concerned with multifaceted macroscopic strategies, while there is less consideration of spatial linkages between regions.

3 Research tools and methodology

3.1 Subjects of the study

Lishui City, Zhejiang, China.

On September 29, 2019, Zhejiang Daily published a series of special editions on "70 years of journey to see Lishui" - intensive development, urban-rural integration, and forge ahead to create a new model county of urbanization. As a typical underdeveloped region in China, Lishui City is located in the Yangtze River Delta and the combination of Zhejiang Province and Fujian Province in the southwest of Zhejiang Province, its urbanization development is extremely prominent to the national economic development, and its development experience has strong significance. At the same time, its information is published timely and complete, the number of counties is appropriate, and the development among counties has a distinct hierarchy. Therefore, the selection of Lishui City, Zhejiang Province as the research object has certain research value.

3.2 Research Methodology

From the purpose of the study, in order to improve the authenticity and credibility of the case analysis, this paper mainly adopts literature research method, Analytic Hierarchy Process (AHP), Geographically Weighted Regression Analysis (GWR), cluster analysis and mathematical and statistical methods to objectively evaluate and comprehensively analyze the urbanization development level of Lishui City from 2015 to 2019.

3.2.1 Analytic Hierarchy Process（AHP）

Analytic Hierarchy Process is a multi-criteria decision making method that combines qualitative and quantitative approaches, which can model and quantify decision makers' thinking about complex systems, and decision makers need to divide the problem into several levels and several factors in the modeling process, compare different factors, and finally arrive at the weights of different options to decide the final solution (Pu et al., 2018).Analytic Hierarchy Process consists of five steps. Modeling the hierarchical structure; Constructing the judgment matrix; Hierarchical single ranking; Matrix consistency test; Hierarchical total ranking (Van Der Gaag, 1996).

3.2.2 Geographically Weighted Regression Analysis (GWR)

The most common technique used in geographic analysis is simple linear regression, which assumes that variation across space is universal, but that this is non-permanent and does not occur in all spatial settings (Shabrina et al., 2021). When the prevalent spatial variation in the

hypothesis has a large differential impact on the factors of the dependent variable, it is necessary to introduce spatial relationships into the impact on the model, i.e., to introduce geographically weighted regression. This method extends and broadens the traditional linear regression technique to incorporate spatial heterogeneity across regions into the variables by allowing parameter estimates to vary locally, thus making the results more precise (Fotheringham et al., 2003).

The calculation process for the geographically weighted regression is shown below.

(1) Using some algorithm (CV or AIC), determine the bandwidth of the study and thus the range at each calculation.

(2) Determine the kernel function based on the bandwidth, and thus determine the weights to be used in the computation - what distance, corresponding to what computational weight.

(3) With one of the sample points as the center and the bandwidth as the radius, the window (calculation range) is opened and all sample points inside the calculation range are included in the calculation. Also, according to the kernel function, let the calculation weight of the sample points that are close to the window be large and the calculation weight of the sample points that are far away be small.

(4) The regression equation for the central sample point is obtained.

(5) Repeat steps 3 and 4 for the next sample point until all sample points are completed.

3.2.3 Cluster Analysis

"Cluster analysis" is the process of finding a collection of similar elements in a set of unlabeled data, in which all elements in the data are grouped according to their proximity, so that the "differences" between similar data are as small as possible and the "differences" between different categories of data are as large as possible, providing useful information for further data analysis (Xu & Qi, 2018). "SPSS (Statistical Product and Service Solutions), which provides useful information for further data analysis (Xu & Qi, 2018), is commonly used for analysis. "Statistical Package for Social Sciences", is one of the world's famous statistical packages for social sciences, medicine, economics and ecology, with the advantages of friendly interface, easy operation and easy learning (Luo, 2011). The commonly used clustering modules in SPSS are two-step clustering, systematic clustering, k-mean clustering etc., with different focuses and very different conclusions.

4 Empirical analysis

4.1 Data sources

In order to better and truly show the comprehensive urbanization development level of Lishui City, Zhejiang Province, this paper downloads from the official website of Lishui City Bureau of Statistics the 2016-2020 Lishui City Statistical Yearbook jointly compiled by Lishui City Bureau of Statistics and Lishui Survey Team of National Bureau of Statistics, which is compiled mainly by compiling information based on the sample survey of urban households and the sample survey of rural households in 9 counties (cities and districts), with a total of 11 chapters, including comprehensive, agriculture, work industry, transportation and postal and telecommunication industry, which can comprehensively reflect the national economic and social development of Lishui City and use SPSS software to deeply analyze the tendency of data changes.

4.2 Construction of evaluation indicators

In order to objectively and scientifically evaluate the current situation of urbanization development in Lishui City from 2015-2019, the principles of people-oriented, scientific and representative are followed in selecting indicators and establishing the indicator system. One primary indicator, four secondary indicators and 17 tertiary indicators are selected to deeply construct the urbanization development evaluation indicator system of Lishui City in 2015-2019 through yaahp software.

The three-level form is adopted to divide the evaluation indicators. Among them, the comprehensive urbanization index indicators are at the first level (decision-making target); the second level (intermediate level elements) includes 4 indicators at the population dimension, economic dimension, social dimension and environmental dimension, corresponding to 17 indicators including urbanization rate, GDP per capita, number of health institutions (excluding clinics) and industrial wastewater emissions; the third level (decision-making level), including 9 counties in Lishui City. The next level corresponds to the upper-level category, and the corresponding indicator weights are obtained by applying hierarchical analysis for importance assignment, and its hierarchical structure model is shown in Figure 1.

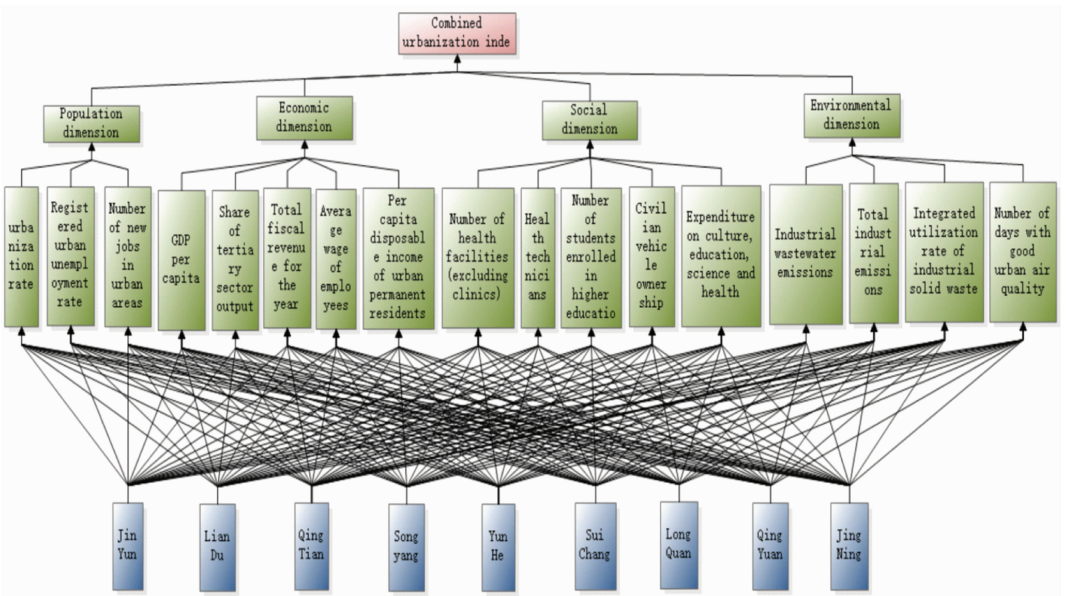

Figure 1 Analytic Hierarchy Process model

Since the main goal of this part is to carry out the weight indicator construction, therefore, in the actual operation of yaahp software, only two counties, Jinyun County and Liandu District, are placed in the decision layer, and the correspondence with other counties is deleted, which in essence does not affect the generation of the actual results of each indicator weight. Immediately after that, by comparing two and two with each other between different indicator layers and inputting the comparison value, the consistency indicator is lower than 0.1, and finally we get the urbanization development evaluation indicators of Lishui City for 2015-2019, i.e., Table 1, in which the population dimension accounts for 23.68%, the economic dimension accounts for 38.99%, the social dimension accounts for 28.38% and the en-

vironmental dimension accounts for 8.92%.

Table 1 Lishui City Urbanization Development Evaluation Indicators, 2015-2019

Primary indicator	Secondary indicators	Tertiary indicators	Indicator weight %
Combined urbanization index	Population dimension	urbanization rate	5.00
		Registered urban unemployment rate	10.29
		Number of new jobs in urban areas	8.39
	Economic dimension	GDP per capita	8.06
		Share of tertiary sector output	7.55
		Total fiscal revenue for the year	12.96
		Average wage of employees	4.95
		Per capita disposable income of urban permanent residents	5.47
	Social dimension	Number of health facilities (excluding clinics)	4.64
		Health technicians	4.35
		Number of students enrolled in higher education	7.55
		Civilian vehicle ownership	4.64
		Expenditure on culture, education, science and health	7.20
	Environmental dimension	Industrial wastewater emissions	2.32
		Total industrial emissions	2.14
		Integrated utilization rate of industrial solid waste	2.14
		Number of days with good urban air quality	2.32

4.3 Data sources and their processing

According to the availability and comparability of data, the Lishui City Statistical Yearbook from 2015 to 2019 was consulted, and after the data obtained were summarized and organized accordingly, the basic data table of Lishui City as shown in Table 2 was obtained to lay the foundation for the next calculation of standardized conversion, and to analyze the change of urbanization in Lishui City more precisely and clearly within 5 years.

Table 2 Lishui City Base Data, 2015-2019

	year	2015	2016	2017	2018	2019
Population dimension	Urbanization rate %	56.40	58.00	59.70	61.50	63.00
	Registered urban unemployment rate %	2.93	2.87	2.66	1.91	1.87
	New in town Number of employed persons \ 10,000	1.55	1.85	1.84	2.25	3.57

	year	2015	2016	2017	2018	2019
Economic dimension	GDP per capita \$	51632.00	55772.00	59674.00	63611.00	66936.00
	Share of tertiary sector output	49.01	50.64	53.37	53.97	54.53
	Total fiscal revenue for the year \ billion	151.60	164.87	180.46	221.18	228.13
	Average wage of employees \$	77238.00	85058.00	92928.00	103259.00	110875.00
	Permanent urban residents Disposable income per capita \$	32875.00	35968.00	38996.00	42557.00	46437.00
Social dimension	Number of health institutions (excluding clinics)	334.00	333.00	322.00	326.00	332.00
	Health technicians	17237.00	18401.00	19104.00	19679.00	20475.00
	Number of students enrolled in higher education	37614.00	36724.00	37359.00	39908.00	36887.00
	Civilian vehicle ownership	281735.00	320957.00	358644.00	393646.00	428520.00
	Expenditure on culture, education, science and health	928511.00	1058941.00	1174182.00	1288810.00	1457775.00
Environmental dimension	Industrial wastewater emissions \ million tons	5710.19	3757.17	3012.56	2603.18	2620.03
	Industrial emissions Total volume\billion cubic metres	751.83	511.25	923.23	875.74	820.17
	Industrial solid waste Overall utilization rate	95.13	90.20	85.64	94.54	99.87
	Urban air quality Number of good days	327.00	349.00	340.00	347.00	358.00

(1) Adopt the min-max standardization method to linearly transform the data. In order to make the selected indicator data comparable, it is necessary to standardize the indicators of different units and different scales. In this paper, the min-max standardization method is used to standardize the indicator data, and when standardizing the indicators, it is necessary to determine the positive and negative efficacy of the indicators. For the whole system, the positive efficacy indicator (the top side) is the indicator with the higher attribute value, and the negative efficacy indicator (the bottom side) is the indicator with the smaller attribute value, where the formula is as follows.

$$X'_{ij} = \begin{cases} \dfrac{X_{ij} - X_{j,\min}}{X_{j,\max} - X_{j,\min}} \\ \dfrac{X_{j,\max} - X_{ij}}{X_{j,\max} - X_{j,\min}} \end{cases}$$

In the formula (Cai et al., 2016),X_{ij} denotes the original value of the jth factor indicator in year i before processing, X'_{ij} denotes the value of the jth factor indicator in year i after processing, $X_{j,max}$,$X_{j,min}$ *is the upper and lower limit of the indicator at the threshold of system stability,* $0 \le X'_{ij} \le 1$.

Table 3 Standardized data for Lishui City, 2015-2019

	2015	2016	2017	2018	2019
Urbanization rate %	0.00	0.24	0.50	0.77	1.00
Registered urban unemployment rate	0.00	0.06	0.25	0.96	1.00
Number of new urban jobs \ 10,000	0.00	0.15	0.14	0.35	1.00
GDP per capita \$	0.00	0.27	0.53	0.78	1.00
Share of tertiary sector output	0.00	0.30	0.79	0.90	1.00
Total fiscal revenue for the year \ billion	0.00	0.17	0.38	0.91	1.00
Average wage of employees \$	0.00	0.23	0.47	0.77	1.00
Per capita disposable income of urban permanent residents \ Yuan	0.00	0.23	0.45	0.71	1.00
Number of health institutions (excluding clinics)\	1.00	0.92	0.00	0.33	0.83
Health technicians	0.00	0.36	0.58	0.75	1.00
Number of students enrolled in higher education	0.28	0.00	0.20	1.00	0.05
Civilian vehicle ownership	0.00	0.27	0.52	0.76	1.00
Expenditure on culture, education, science and health	0.00	0.25	0.46	0.68	1.00
Industrial wastewater emissions \ million tons	1.00	0.37	0.13	0.00	0.01
Total industrial waste gas emissions \ billion cubic meters	0.58	0.00	1.00	0.88	0.75
Integrated utilization rate of industrial solid waste	0.67	0.32	0.00	0.63	1.00
Number of days with good urban air quality	0.00	0.71	0.42	0.65	1.00

(2) Descriptive statistics were performed on the underlying data by variable, and the corresponding mean, median, extreme deviation, variance, standard deviation, and coefficient of variation were calculated and analyzed.

(3) Geographically weighted regression model. The essence of the geographically weighted regression model (GWR) is a locally weighted least squares method, where the weights are a function of the distance from the geospatial location where the point to be estimated is located to the geospatial location of each of the other observations. The variation of these parameters estimated at each geospatial location with the studied geospatial location characterizes the non-stationarity of the spatial data.

5 Analysis of results

5.1 Descriptive statistical analysis

The descriptive statistics of the "base data of Lishui City from 2015 to 2019" were conducted by variable , and the corresponding data of mean, median, extreme deviation, variance, standard deviation and coefficient of variation were obtained. Results of the descriptive statistics of the basic data of Lishui City from 2015 to 2019 are shown in Table 4.

Table 4 Descriptive statistics of the base data of Lishui City, 2015-2019

	average value	median	abysmal	variance (statistics)	(statistics) standard deviation	coefficient of
Urbanization rate %	59.72	59.70	6.60	5.58	2.64	0.044
Registered urban unemployment rate	2.45	2.66	1.06	0.22	0.52	0.212
Number of new urban jobs \ 10,000	2.21	1.85	2.02	0.51	0.80	0.361
GDP per capita \$	59525.00	59674.00	15304.00	29604995.20	6083.28	0.102
Share of tertiary sector output	52.30	53.37	5.52	4.50	2.37	0.045
Total fiscal revenue for the year \ billion	189.25	180.46	76.53	924.07	33.99	0.180
Average wage of employees \$	93871.60	92928.00	33637.00	146497093.04	13532.23	0.144
Permanent urban residents Disposable income per capita \$	39366.60	38996.00	13562.00	22799581.04	5338.49	0.136
Number of health institutions (excluding clinics)\	329.40	332.00	12.00	21.44	5.18	0.016
Health technicians	18979.20	19104.00	3238.00	1222457.76	1236.15	0.065
Number of students enrolled in higher education	37698.40	37359.00	3184.00	1322494.64	1285.74	0.034
Civilian vehicle ownership	356700.40	358644.00	146785.00	2684842345.04	57931.45	0.162
Expenditure on culture, education, science and health	1181643.80	1174182.0	529264.00	33384180811.76	204279.77	0.173
Industrial wastewater emissions \ million tons	3540.63	3012.56	3107.01	1351810.99	1299.91	0.367
Total industrial waste gas emissions \ billion cubic meters	776.44	820.17	411.98	20850.30	161.44	0.208
Integrated utilization rate of industrial solid waste	93.08	94.54	14.23	23.22	5.39	0.058
Number of days with good urban air quality	344.20	347.00	31.00	106.96	11.56	0.034

As can be seen from Table 4, the mean and median of each indicator reflect the development trend of each indicator in 2015-2019; the extreme deviation reflects the fluctuation range of each data in the last five years; the variance reflects the deviation of each indicator from its mathematical expectation (i.e., the mean) in the last five years, among which the variance of urban registered unemployment rate is the smallest and the variance of cultural, educational, scientific and health expenditure is the largest; the magnitude of the standard deviation is influenced by the variance, while the magnitude of the coefficient of variation is determined by the standard deviation versus the mean.

5.2 Objective evaluation of composite scores and analysis

Based on the relationship between the standardized data values of each factor and its weight, the calculation is carried out according to the formula: $\sum_{j=1}^{n} W_j X_{ij}$ (W_j denotes the weight coefficient of the jth factor indicator), and the comprehensive evaluation value of urbanization development in Lishui City for 2015-2019 is obtained S.The following is the comprehensive score and analysis of the objective evaluation of the quality of urbanization development in Lishui City from 2015 to 2019, and the results are shown in Figure 2.

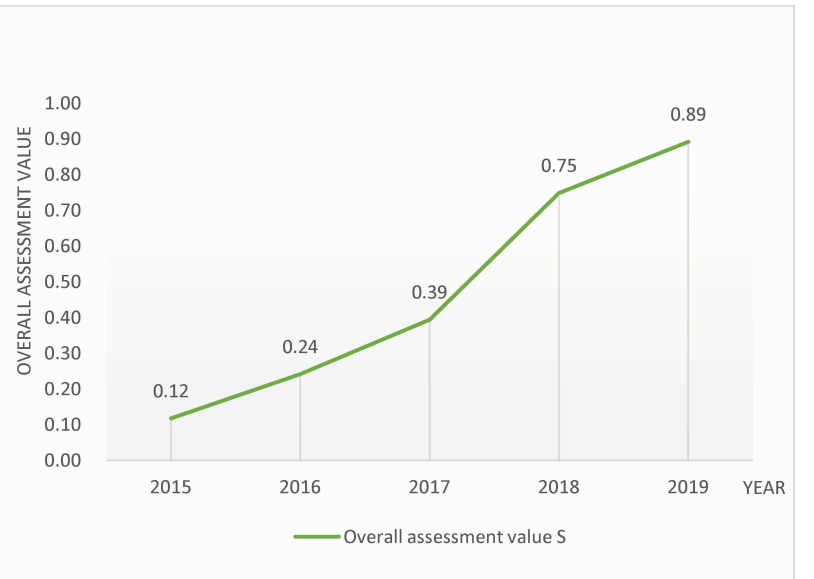

Figure 2 City of Lisle 2015-2019 Composite Assessment Value

As can be seen from Figure 2, the comprehensive evaluation value of urbanization development in Lishui City has rapidly increased from 0.12 in 2015 to 0.89 in 2019, with an average annual growth rate of 69.4% from 2015 to 2019, and the overall annual growth rate from 2015 to 2019 has shown a slowing trend, with the highest annual growth rate of 105.3% already in 2015-2015. Although the annual growth rate has decreased, the comprehensive evaluation value still shows an upward trend. This indicates that Lishui City Government is paying more and more attention to urbanization and is committed to promoting the development of towns and rural areas together and improving the living conditions of the people, and the increase in the base of the previous year is what led to the overall lower annual growth rate.

5.3 Geographically weighted regression analysis

The results from the GWR analysis using ArcGIS are shown in Figure 3.

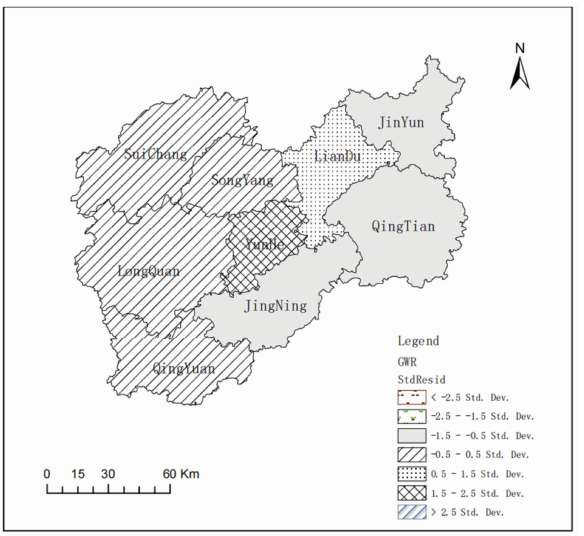

Figure 3 Spatial correlation display of urbanization development in Lishui City by county and city

By analyzing the spatial correlation of urbanization in the counties of Lishui City, it can be seen that Yunhe County has the greatest influence on the level of urbanization in Lishui City in terms of spatial relationship, followed by Liandu District. The data show that the annual gross product level Liandu District has the highest index, followed by Qingtian County and Jinyun County, and the annual gross product of the three exceeds the other counties by more than two times, so they have a more spatial influence on the economic development of urbanization. Liandu District as the municipal district of Lishui City has a slightly lower influence than Yunhe County in the spatial correlation analysis because its larger population base makes the urbanization rate relatively low, and the database of other indicators in the previous year is also relatively large, making the development rate relatively low, but the overall development still maintains the leading trend.

5.4 Cluster Analysis

The mean values of 17 indicators from nine counties in Lishui City, Liandu District, Qingtian County, Jinyun County, Suichang County, Songyang County, Yunhe County, Qingyuan County, Jingning County and Longquan County from 2016-2019 were imported into SPSS for hierarchical cluster analysis, and the "intergroup linkage" was selected, i.e., the average of the distance between an individual and each individual in a small class (Li & Ma., 2012), which can reduce the influence of errors caused by extreme values on the discrimination of classification distances, resulting in the cohesive state table shown in Table 5.

In Table 5, the first column indicates the first step of the cluster analysis; the second and third columns indicate which two samples or small classes in this step cluster into one class; the fourth column is the individual distance or small class distance; the fifth and sixth columns indicate whether the individuals or small classes involved in this step cluster, 0 indicates the samples, non-0 indicates the small classes generated by the first step cluster participate in this step cluster, and the seventh column indicates the results of this step cluster will be used in the following steps in the following steps (Zhang et al., 2015). For

example, in the first step, No. 8 (Jingning County) and No. 9 (Longquan County) are clustered into one class, and the individual distance is 1.49E+08. This subclass will be used in the clustering in the second step, and the other clusters are also obtained from this reasoning, which is visualized as a tree diagram in Figure 4, showing the distance and joint relationship between the subclasses clearly.

Table 5 Table of cohesive states for hierarchical cluster analysis

Clustering Table						
Steps	Cluster Combination		Coefficient	First appearance of order clusters		
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	The next level
1	8	9	1.49E+08	0	0	2
3	4	5	2.61E+09	0	2	4
4	4	7	6.16E+09	3	0	6
5	2	3	1.14E+10	0	0	7
6	4	6	1.75E+10	4	0	7
7	2	4	3.52E+10	5	6	8
8	1	2	5.07E+10	0	7	0

Through cluster analysis, according to the urbanization development process, the nine counties in Lishui City are divided into several types according to the quality evaluation index model established in the previous paper, to judge their development characteristics and point out the development advantages and shortcomings, so as to better promote the quality development of urbanization. As can be seen in Figure 4, there are three types of classification, and the cross-section of the number of clusters is determined as three types based on the principle of moderate cluster size and distinct reflection of the development pattern of the discipline (Wu, 2017), with Liandu District being farther away and individually referred to as the "clustering and promotion type"; Qingtian County and Jinyun County being closer in the same dimension. The remaining six counties, Jingning County, Longquan County, Songyang County, Suichang County, Qingyuan County and Yunhe County, have relatively small urbanization development distances and are classified as "weak development type". In order to present the characteristics of the categorized counties concretely, this paper standardizes the eigenvalues of the indicators and maps them to the interval [0, 1] to obtain Figure 5.

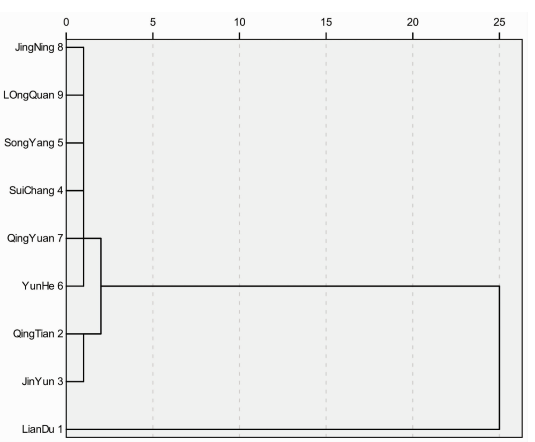

Figure 4 Hierarchical clustering analysis tree diagram

5.4.1 Gathering and upgrading type

Represented by Liandu District, it is far ahead of other counties in terms of population, economic, social and environmental level development, but more negligent of the environmental level, typically focusing on urbanization development and light-on environment. Liandu District plays a leading role in promoting urbanization according to the requirements of the provincial and municipal levels, and the living conditions of urban residents have greatly improved, and their income and living conditions have been significantly enhanced; various social undertakings such as science and technology, education, medical care, health, culture and sports have flourished to improve the quality of life of urban residents, and the urbanization rate is as high as 77.2%, ranking first in the city. However, this high-speed development is built on the traditional development path of high resource consumption, which has accumulated more environmental problems in a short period of time due to the large industrial wastewater discharge and low comprehensive utilization rate of industrial solid waste. In recent years, the government of Liandu District has also realized the importance of environmental protection and is continuously improving the industrial structure, increasing the proportion of tertiary industries and increasing the efforts of environmental protection, so as to promote high speed to high-quality development through comprehensive upgrading.

5.4.2 Coordinated promotion type

Taking Qingtian and Jinyun counties as typical representatives, the values of the four major levels are distinct, i.e., the urbanization development is balanced at a medium speed, which can fully reflect the comprehensive long-term development vision of the two county governments, which can combine the environment and urbanization development and move forward at a more steady pace. In the process of redevelopment, the governments of the two counties uphold the advanced concept of "those who do not plan the whole situation are not able to plan a region", optimize the spatial layout, ensure the effective coordination and operation of the four levels; clarify land use, rational planning of production and living land, highlighting priorities and strictly controlling construction land; promote the "production, living and ecological" infrastructure. production, living and ecological" infrastructure construction, with special emphasis on building a long-term mechanism for sustainable urbanization development, and effectively improving the county's living environment. In short, the coordinated promotion type is more synchronized in all aspects of development, but it is also necessary to further accelerate the process, such as the use of new technologies to achieve digital and intelligent governance, so as to release the development potential, and thus achieve faster and better speed up urban-rural integration efforts (Yi et al., 2021).

5.4.3 Weak development type

Represented by Suichang County, Songyang County, Yunhe County, Qingyuan County, Jingning County and Longquan County, all four levels of development are mediocre with no obvious advantages and almost all need to be upgraded and developed. The indicators show that the environmental level has a more objective value compared to the other levels, which is due to the fact that these six counties do not follow the integration concept and strategic planning of the provincial and municipal urbanization strategies, and are more backward in development, so this is a low level of environmental protection; the economic level is more generally developed, and the other levels are far behind, with almost no development. In addition, the lack of good location conditions and the failure to form a unique core

competitiveness of industry can not attract the rural population to work in towns and cities, and the urbanization rate is low. In this context, its development can be driven by the characteristic tourism industry, and at the same time, under the integration concept, the other two types of towns can also obtain greater urbanization development space through the mode of leading the weak with the strong, using resource technology exchange and industrial merging.

As shown in Figure 5, the development of the nine county towns in Lishui City can be categorized into three types, including agglomeration and enhancement type, coordination and promotion type and weak development type, which show different characteristics at the population dimension, economic dimension, environmental dimension and social dimension, respectively. According to this diagram, the 9 counties in Lishui City can clearly see the weak development level according to the type they are in, and can ask for successful experiences from the type counties with advantageous positions, and after integrating their own geographical location, resource distribution and other realities, formulate targeted development strategies to further promote the process of new urbanization.

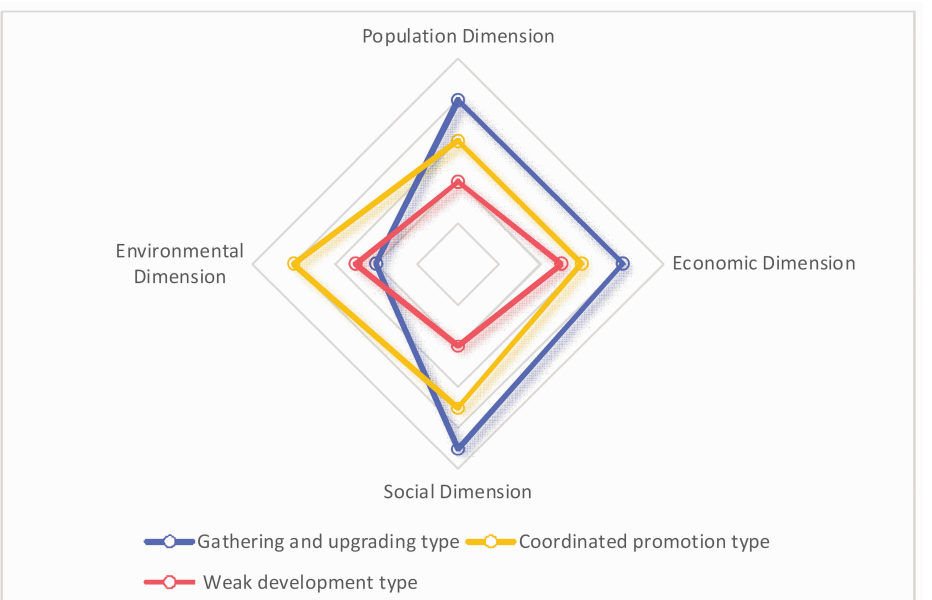

Figure 5 Visualization of County Category Characteristics

6 Conclusion

The following conclusions were drawn from the analysis of data on urbanization development indicators in Lishui City for the period 2015-2019.

From the population dimension, the urbanization rate in Lishui City is increasing in a positive trend and the level of sustainable development is good in the long term. Therefore, it has a good foundation for development during the 14th Five-Year Plan period and a strong practical basis for further higher-level development planning in accordance with the target requirements.

From the economic dimension, the city's GDP per capita, the proportion of output value of the three industries, and the total annual fiscal revenue are all increasing, and although they

are still at a lower level compared to other cities in the province, the level of development has increased significantly compared to previous years. Therefore, as "economy is the basis of urbanization development", the city should continue to maintain the positive economic development momentum, and more deeply stabilize the urbanization rate to avoid reverse urbanization.

From the social dimension, although the number of public infrastructures such as medical equipment and educational facilities has not increased significantly, the number of health personnel and school students are increasing, from which it is reflected that the scale of facilities has undergone improvement and expansion. Therefore, Lishui City has fully considered the importance of infrastructure development in the urbanization process for the long-term urbanization rate to rise, but the capacity of buildings, facilities, etc., has a certain limit, and it is recommended to further increase the number.

From the environmental dimension, industrial wastewater and solid waste are treated well, and the rate of development of secondary industries is rapidly increasing, so overall the air condition in Lishui City is good. However, with the development of urbanization, industrial waste gas treatment still needs to be improved to further reduce air pollution.

From the spatial correlation, the development of the nine counties and cities in Lishui City is relatively close, among which Qingtian County has the greatest influence and plays a key role in the development of urbanization in Lishui City.

From the clustering analysis, the 9 major counties in Lishui City are divided into 3 categories according to the distance criteria. The first category, "aggregation and promotion type", Liandu District, represents the importance of urbanization process, urbanization is far ahead, but ignored the development of ecological civilization. The second category, "coordinated promotion type", Qingtian and Jinyun counties, representing the four major levels of the promotion effect is equivalent, in the process of medium-speed balanced development, need to further speed up. The third category, "weak development type", has no major development advantages and is weak in all aspects of development. It needs to improve the level of government thinking, actively self-help and seek help and support from other towns.

In conclusion, although the level of urbanization development in Lishui City is still at a low level in the province, but looking at the data comparison of each year, the development trend of urbanization in Lishui City is good and people's living standard has been greatly improved. At the same time, for the weak indicators of urbanization development in Lishui, this paper puts forward relevant suggestions.

7 Responses and recommendations

In March 2021, the Fourth Session of the 13th National People's Congress (NPC) voted to adopt the Resolution on the Outline of the 14th Five-Year Plan (2021-2025) and Vision 2035 of the National Economic and Social Development of the People's Republic of China. During the 14th Five-Year Plan, the connotation of a livable city should be enriched, and on the basis of building a green, intelligent, innovative, cultural and compact city, more attention should be paid to building a healthy, consumer-oriented and resilient city (Yang, 2021). Therefore, Lishui City needs to insist on the combination of goal-oriented and problem-oriented, and the unification of top-level design and asking the people, and further clarify the breakthrough direction of urbanization as "promoting a new type of urbanization with people at the core". At the same time, in the development process of urbanization, it is

necessary to achieve balanced development of economy, society, resources and environment (Li & Wang, 2017).

7.1 Citizenship of the population

A higher level of openness and the unification of domestic markets can facilitate the effective formation of a new urbanization development model and further promote the free movement of people, resources, etc. (Yang, 2021). First, the citizenship of peasants. Improve the treatment of migrant workers and ensure basic housing, catering, transportation and other guarantees for them to work outside the city in order to attract more idle rural laborers to the city and further increase the urbanization rate.Although the urbanization rate has been increasing in recent years, the growth rate is decreasing, so there is a need to improve the utilization of idle rural labor as one of the methods to promote urbanization by improving the basic treatment of migrant workers. Second, the reform of the household registration system should be increased. The government should accelerate the implementation of a system of mutual recognition of residence permits and mutual transfer of household registration within urban clusters and metropolitan areas, so that rural migrants can freely choose to live in or leave the city and register in the corresponding area (Wei et al., 2021). In addition, to improve the supporting reform of the household registration system, Lishui City should further adhere to the implementation principle of free household registration, implement the reform concept of realizing the restriction of household registration as an exception, and fully open the household registration system on a city-by-city basis. This approach enables equal treatment of people in the city who belong to rural households, with greater added value, including access to health care, education for children and housing benefits (Gong et al., 2020). Enabling more outsiders to access the same basic services here can accelerate the process of quality urbanization.

7.2 Modern metropolitan areas

The proposal to optimize the setting of administrative divisions, give full play to the leading role of central cities and urban agglomerations, build modern metropolises, and support the effective concentration of population in urbanized areas marks urbanization as a national medium- and long-term development strategy (Central Committee of the Communist Party of China, 2020). Firstly, the core element to solve the urban-rural problem and promote coordinated regional development is to narrow the urban-rural gap in metropolitan areas, including various aspects such as residents' income, industrial structure, and so on (Yao & Jiang, 2021). First, broaden the financing channels for agricultural activities and improve the supply structure; second, increase the importance of rural education and increase investment; third, long-term planning is needed to safeguard the long-term interests of farmers (Yuan et al., 2020). Second, on the basis of reducing the gap, the primary characteristic of modern metropolitan areas is the expansion of scale, which is closely related to the specialization and diversification of cities (Fu & Hong, 2011). Their increase can further accelerate the process of wrap-around mutual promotion of metropolitan areas and urban agglomerations, expanding the scale of cities and exerting core influence. Finally, creating infrastructure integration. Due to the wider coverage and novel evaluation indicators, metropolitan areas focus more on the transformational development of manufacturing industries, emphasizing the formation of regional transportation conditions, innovation environment and collaborative governance patterns of regional industrial space (Salazar et al. , 2021). Therefore, modernized metropolitan areas such as development center regions need

to focus on strengthening regional innovation and promoting the formation of innovation transformation core regions (Liu et al., 2018).

7.3 Coordinated development of the industry chain

Lishui City as a whole can form a large town to drive the development of small towns related to the development trend of the industry chain, nine counties and cities to help each other, and jointly promote urbanization development, reduce spatial differences, the formation of benign competition in the development of the situation, through the development of each county and city to achieve the overall urbanization development of Lishui City. First of all, according to local conditions. Focus on the development of Lishui City's special industries, increase publicity for tourism projects such as farmhouses, and promote the economic development of related industries while also raising the shortcomings of the lower rural income. Second, innovation system. The "Made in China 2025" plan proposes to focus on industrial innovation, continue to implement the innovation-driven strategy, and improve core competitiveness (Zhou et al., 2021). Lishui City can take the lead in exploring the space for deep innovation and transformation, exploring the path of digital transformation in change, giving full play to the advantages of industrial system innovation, continuously releasing policy dividends, and empowering the coordinated development of urbanized industries. In addition, increase the proportion of tertiary industry. Break the institutional, digital, and information barriers, further extend the industrial chain links, expand the coverage of the modernized metropolitan area, and absorb the rural population including those who come to the city for employment as well as industrial and surplus labor, thus further expanding the development space of consumer services and forming a high-quality virtuous circle (Zeng & Xia, 2016).

7.4 Quality liveable cities

At the scientists' conference, President Xi Jinping stated that the key to urbanization development is to improve the research environment ecology (Poo, 2021). First, focus on environmental development to reduce industrial wastewater and gas emissions. The air quality can be guaranteed by reducing the rate of industrial waste gas emissions through the introduction of foreign waste gas treatment technologies. Attention should be paid to the rationalization of wastewater treatment planning, pooling preliminary treated industrial wastewater with urban wastewater, and gradually centralizing urban wastewater treatment to improve wastewater treatment efficiency and allocate resources more effectively (Sun et al., 2021). Second, a scientific pollution control investment system should be established to accelerate the improvement of the existing pollution control system through a combination of legal, economic and administrative instruments (Yu, 2021). Just as in environmental governance, enterprises are the source of environmental pollution and the subject of governance, while the government is the subject of environmental standard-setting and supervision (Zhao & Jin, 2021). Through clear institutional construction, enterprises can be motivated to improve their existing pollution management measures and equipment, while the government can also facilitate the execution of regulatory functions and be alert to non-compliant measures. In addition, the improvement of the structure and function of urban ecosystems is to a certain extent closely related to the production activities of urban populations (Cai et al., 2021), and it is necessary to effectively regulate enterprise production, strengthen the quality and cultural education of workers, and further increase the coverage of compulsory education. In particular, the introduction of talents and the treatment of

general workers in less economically developed inland areas should be strengthened in order to attract the inflow of labor, promote innovation and development, and enhance economic potential (Chang & Chen, 2021).

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