Ecological Livability Evaluation Based on Remote Sensing Technology - A Case Study of Shijiazhuang

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Abstract: Water pollution and traffic jams make the city’s living environment a great test. The public demand for creating a livable urban environment has become more and more intense with the rise of circulation, green and low-carbon development trends. Based on the statistical data and LANDSAT-8 OLI remote sensing of Shijiazhuang as the main data source, this paper extracts 19 indicators according to the principle of establishing the ecological livability evaluation index, and the practical circumstance and data of the study district based on remote sensing technology. This paper affirms the achievements of the construction of the ecological livable city, but there are some aspects to be improved, including economic development, infrastructure, science and technology culture, ecological environment and social security.

1. Introduction
With the deepening of urbanization and industrialization, the problems of urban environmental quality and ecosystem imbalance have been constantly increasing. Shijiazhuang is not only the important support area of Beijing-Tianjin-Hebei Region “third pole” and the construction of Xiong’an New Area, but also one of the most polluted areas in North China. Many scholars in our country combine economic indicators and ecological indicators from the perspective of sustainable development[1]. Relevant scholars think that livable cities not only require high level of economic development, but also should have strong potential for development, and only improving economic level can provide material basis and social security for ecological livable construction[2]. There are many cases by applying GIS and RS technology in ecological suitability evaluation process. Fu Bo evaluated the overall livability of Changchun by using the mean variance and multi-objective linear weighting function method in combination with GIS and remote sensing technology[3]. Based on the natural features and data accessibility of the lake, Ding Leilong constructed the livable evaluation index system by using remote sensing images and other data in the study area[4]. Because of the scale problem of remote sensing image, instantaneous and imaging methods, the index precision is not accurate enough to meet the requirements, and single extraction from remote sensing image index cannot be used for one type of study, which must be combined with other indicators to analyze the comprehensive evaluation. This paper analyzes the ecological livable level in different regions, which is beneficial to improve the overall ecological livable level of shijiazhuang.

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2. Establishment of Index System and Data Processing

2.1 Establishment of Index System
The city is a comprehensive system, which not only affects many factors, but also influences each other[5]-[6]. This paper extracts five groups of 19 indicators according to the principle of establishing the ecological livability evaluation index (Table 1).

2.2 Data sources and Processing
According to the above index system, this article selects the statistical data and remote sensing image in Shijiazhuang in 2016. Combined with the “Land Use Status Classification Standard” and the requirements of this article, the land use type of Shijiazhuang can be divided into: cultivated land, water, construction land, forest and unutilized land[7]-[8].

3. Main Research Methods

3.1 The Index Value
This paper mainly extract the ecological environmental indicator. The other indicators are derived from statistical yearbook data and economic and social development statistical bulletin.

3.2 Ascertainment of Weights
Because the data level of each index is relatively large, the selected indexes cannot be directly applied to the model in the back, and the data should be normalized[9]. The calculation model is:

\[ R_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \quad (1) \]

\[ R_{ij} = \frac{\max(x_{ij}) - x_{ij}}{\max(x_{ij}) - \min(x_{ij})} \quad (2) \]

In this paper, analytic hierarchy process (AHP) method is used to determine the weight of the primary factors, and the weight of the secondary factors is calculated according to the principal component analysis (PCA)[10]-[11]. The final result is shown in Table 1.

| Target layer | Primary factors | Weight | Secondary factors                                                                 | Weight |
|--------------|-----------------|--------|-----------------------------------------------------------------------------------|--------|
| Economic development | B1 | 0.09 | Per capita revenue C1                                                             | 0.074  |
|                |                 |        | Per capita of GDP GDP C2                                                          | 0.077  |
|                |                 |        | Total investment in fixed assets C3                                               | 0.022  |
|                |                 |        | Per capita living expenses of urban and rural residents C4                       | 0.074  |
| Ecological Livability | A | 0.09 | The proportion of science and technology expenditure accounted for Fiscal expenditure C5 | 0.052  |
| Science and technology culture | B2 | 0.09 | The number of enterprises with R&D activities C6                                  | 0.076  |
|                |                 |        | The number of primary and secondary schools C7                                   | 0.076  |
|                |                 |        | The number of patent applications for industrial enterprises C8                  | 0.073  |
| Infrastructure | B3 | 0.24 | Electricity consumption situation C9                                             | 0.076  |
|                |                 |        | The proportion of general public service expenditure accounted for financial expenditure C10 | 0.034  |
|                |                 |        | Annual water supply C11                                                          | 0.009  |
Ecological environment B4 0.52
Social security B5 0.09

4. Ecological Livability Evaluation of Shijiazhuang

After normalization processing on the original data, this paper calculates the ecological livable index, economic development, science and technology culture, infrastructure, ecological environment and social security according to the weight of each index by using the comprehensive weighted method, as shown in Table 2.

**Table 2. Results of ecological livability evaluation.**

| District                  | A   | B1  | B2  | B3  | B4  | B5  |
|---------------------------|-----|-----|-----|-----|-----|-----|
| Urban district            | 0.034 | 0.2297 | 0.2770 | 0.1101 | 0.0033 | 0.1597 |
| Luquan                    | 0.057 | 0.0429 | 0.0944 | 0.0218 | 0.0973 | 0.0360 |
| Luancheng                 | 0.059 | 0.0470 | 0.0864 | 0.0214 | 0.1002 | 0.0341 |
| Gaocheng                  | 0.067 | 0.0403 | 0.0760 | 0.0106 | 0.1216 | 0.0482 |
| Zhengding                 | 0.054 | 0.0305 | 0.0703 | 0.0216 | 0.0910 | 0.0459 |
| Xinle                     | 0.059 | 0.0155 | 0.0598 | 0.0072 | 0.1073 | 0.0362 |
| Jingxing                  | 0.085 | 0.0237 | 0.0534 | 0.0122 | 0.1551 | 0.0335 |
| Jinzhou                   | 0.077 | 0.0149 | 0.0465 | 0.0265 | 0.1334 | 0.0358 |
| Yuanshi                   | 0.074 | 0.0122 | 0.0446 | 0.0107 | 0.1366 | 0.0364 |
| Pingshan                  | 0.085 | 0.0248 | 0.0399 | 0.0131 | 0.1546 | 0.0479 |
| Xingtang                  | 0.063 | 0.0058 | 0.0395 | 0.0210 | 0.1099 | 0.0352 |
| Wuji                      | 0.077 | 0.0101 | 0.0376 | 0.0395 | 0.1288 | 0.0353 |
| Lingshou                  | 0.072 | 0.0016 | 0.0361 | 0.0053 | 0.1348 | 0.0308 |
| Shenze                    | 0.074 | 0.0068 | 0.0358 | 0.0105 | 0.1357 | 0.0202 |
| Gaoyi                     | 0.074 | 0.0086 | 0.0328 | 0.0150 | 0.1336 | 0.0160 |
| Zhaoxian                  | 0.089 | 0.0121 | 0.0326 | 0.0099 | 0.1646 | 0.0388 |
| Xinji                     | 0.094 | 0.0490 | 0.0311 | 0.0252 | 0.1676 | 0.0462 |
| Jingxing mining area      | 0.060 | 0.0147 | 0.0304 | 0.0308 | 0.0994 | 0.0080 |
| Zanhuang                  | 0.088 | 0.0077 | 0.0212 | 0.0036 | 0.1659 | 0.0270 |

4.1. Ecological Livable Index

The most ecological livable level in Shijiazhuang is Xinji, as shown in Figure 1 and 2, followed by Zhaoxian and Zanhuang, which has a value of 0.094. Under the premise of vigorous developing the leather city, it strives to create an eco-tourism city with distinctive features, good ecology, perfect facilities and first-class service. The urban ecological livable level is low, which is 0.034. Zhengding and Luquan are better than urban district, which is respectively 0.054 and 0.057. The reason is that these cities have poor ecological environment.
4.1.1. **Economic development.** The highest index of economic development is urban district, which has a value of 0.2297. Its per capita of GDP, total investment in fixed assets, and per capita living expenses of urban and rural residents are higher. The lowest index of economic development is Lingshou, which has a value of 0.0016. Its per capita of GDP and per capita revenue are low, which ranks at the bottom of the city.

4.1.2. **Science and technology culture.** The highest index of science and technology culture is urban district, which has a value of 0.277. Its the proportion of science and technology expenditure accounted for fiscal expenditure, the number of patent applications for industrial enterprises, the number of enterprises with R&D activities, and the number of primary and secondary schools in urban district are higher. The lowest index of science and technology culture is Zanhuang, which has a value of 0.0212. Its the proportion of science and technology expenditure accounted for fiscal expenditure, and the number of primary and secondary schools are lower.

4.1.3. **Infrastructure.** The highest index of infrastructure is urban district, which has a value of 0.1101, and followed by Wuji. The lowest index of infrastructure is Zanhuang, which has a value of 0.0036. Its the proportion of general public service expenditure accounted for financial expenditure and annual water supply is lower.

4.1.4. **Ecological environment.** The highest index of ecological environment is Xinji, which has a value of 0.1676. Its ESV is higher, and Lλ is lower. The lowest index of ecological environment is urban district. Its f and ESV are higher, and Lλ is higher.

4.1.5. **Social security.** The highest index of social security is urban district, which has a value of 0.1597. Its the number of health institutions and the proportion of urban low-income people accounted for the total people are higher. The lowest index of social security is Jingxing mining area, which has a value of 0.008. Its the proportion of registered unemployment accounted for the total population is higher, and the number of health institutions is lower.

5. **References**

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