Evaluation of Intensive Land Use and Countermeasure Prospects in Hexi Corridor of China

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Abstract. Influence of "Belt and Road " international cooperation initiative is continuously expanding. Hexi Corridor in China, as an important geographic area of the land Silk Road, its development degree and influence are constantly prominent. In order to promote efficient and intensive development of Hexi Corridor area, the development data of Hexi Corridor area in recent years are collected from several dimensions in recent years. By using entropy method and tobit model, this paper evaluated degree of intensive land use in Hexi Corridor, to find out the experience and shortcomings of urban development in Hexi Corridor. Then the trend of urban land use and urban development in Hexi Corridor are explored and corresponding countermeasures are put forward.

1. Introduction of Hexi Corridor in China
Hexi Corridor refers to the zonal area in Gansu Province, China, where the Qilian Mountain is in the south and the Longshou Mountain, Helishan Mountain, Mameng Mountain are in the north, with mountain peaks ranging from 2 kilometers to 5 kilometers above sea level. It is named for its location to the west of the Yellow River and its narrow corridor-like shape. It includes five refecture-level cities (Wuwei, Jinchang, Zhangye, Jiayuguan and Jiuquan). Since ancient times, Hexi Corridor has become the hub of central and western China because of its important geographical position as well as its narrow terrain. It can be described as a "throat" connecting China's Central Plains and west areas, and even a "throat" connecting China and Western countries.

In 2013, China proposed the "Belt and Road"(B&R), which is the International cooperation initiative. "The Belt and Road" is the abbreviation of "The Silk Road Economic Belt" and "The 21st Century Maritime Silk Road". By 2015, it has reached a relatively mature stage. Up to now, it has put into concrete practice. Accordingly, China has made great achievements in many aspects of it, such as investment in various cooperative countries, joint-construction of infrastructure between China and foreign countries, cultural and economic exchanges, etc. The influence of B&R has exceeded the scope of China, and has risen to the level of international exchange and economic trade. As an important passage of the land Silk Road, Hexi Corridor has gradually emerged its important position, and has re-entered the vision of the whole country and even the whole world. The Hexi Corridor area, which integrates cultural, economic and historical elements, plays a great role in promoting the construction of underdeveloped areas in western China, the construction of the East-West Economic Community, and cultural exchanges at China and the other European countries.
2. General Situation of Hexi Corridor’s Construction and Development

Overall, among the five prefecture-level cities of Hexi Corridor, Jiayuguan has the smallest area, and Jiuquan has the largest area. For the convenience of obtaining and calculating various data and indexes as well as the consistency of data comparison level, all kinds of data are divided according to the scope of the prefecture-level city. For instance, the data of Jiuquan includes all kinds of data of the county-level cities (Dunhuang City and Yumen City) under its jurisdiction. Wuwei only uses about one third of Jiayuguan construction land while it carries a population 6 times higher than Jiayuguan. As for the financial income, Jiayuguan has the highest per capital fiscal income, which is 7352.44 yuan per person; Wuwei is the lowest, which is 156.84 yuan per person. As for the proportion of three industries, the ranking in Jiayuguan and Jinchang is as follows (from large to small): secondary industry, tertiary industry, and primary industry; the ranking in Jiuquan and Wuwei is as follows (from large to small): tertiary industry, secondary industry, and primary industry; Zhangye's industrial structure is as follows: (from large to small): tertiary industry, primary industry, and secondary industry , As show in Table 1[1].

| Prefecture-level City | Area of Jurisdiction (Square Kilometer) | Construction Land Area (Square Kilometer) | Total Population (10,000 Persons) | Urbanization Rate (%) | Government Receipts (10,000 RMB) | Three Industrial Structures |
|----------------------|----------------------------------------|------------------------------------------|---------------------------------|-----------------------|----------------------------------|---------------------------|
| Jiayuguan            | 2935                                   | 104.54                                   | 24.98                           | 93.43                 | 183664                           | 2.2:51.8:46               |
| Jinchang             | 9593                                   | 43.70                                    | 46.92                           | 70.10                 | 222173                           | 9.2:50.3:40.5             |
| Wuwei                | 33249                                  | 33.46                                    | 182.53                          | 39.72                 | 286177                           | 25.7:29.1:45.2            |
| Zhangye              | 40874                                  | 39.95                                    | 122.93                          | 45.76                 | 263250                           | 25.03:24.11:50.86         |
| Jiuquan              | 191200                                 | 69.86                                    | 112.36                          | 60.27                 | 345025                           | 15.6:32.8:51.6            |

In 2017, the land use structure of each city in Hexi Corridor is quite different. According to the Code for classification of urban land use and planning standards of development land (GB50137-2011), the proportion of residential land in Wuwei and Zhangye is more than 40%. The proportion of land used for administration and public service facilities in Jiayuguan is less than 5%, and the proportion of land used in Jiuquan is higher than 8%; the land for road, street and transportation in Zhangye is less than 10%, and the land for green space and square in Jiayuguan is less than 10%. On the whole, there are three indexes in Jiayuguan that beyond the suitable range. And there is the problem of industrial unitary development; Jinchang and Zhangye have two indexes beyond the suitable range; Wuwei and Jiuquan have only one kind of land proportion outside the suitable range, whose land use structure is relatively reasonable. As show in Table 2[2].

| Prefecture-level City | Residential | Administration and Public Services | Commercial and Business Facilities | Industrial, Manufacturing | Logistics and Warehousing | Road, Street and Transportation | Municipal Utilities | Green Space and Square |
|----------------------|-------------|-----------------------------------|----------------------------------|--------------------------|--------------------------|-------------------------------|----------------------|-----------------------|
| Jiayuguan            | 11.8        | 4.2                               | 6.3                              | 50.6                     | 3.6                      | 14.4                          | 0.6                  | 8.5                   |
| Jinchang             | 18.2        | 6.5                               | 3.7                              | 40.0                     | 3.3                      | 12.3                          | 3.3                  | 12.7                  |
| Wuwei                | 42.2        | 6.6                               | 9.1                              | 1.7                      | 1.1                      | 15.7                          | 1.5                  | 22.1                  |
| Zhangye              | 43.0        | 7.9                               | 7.9                              | 4.9                      | 6.4                      | 6.5                           | 10.6                 | 12.8                  |
| Jiuquan              | 20.7        | 9.0                               | 11.4                             | 10.3                     | 2.4                      | 13.7                          | 2.6                  | 29.9                  |
3. Evaluation of Intensive Land Use in Hexi Corridor

The factor level and index level of land intensive use evaluation are based on the rules of intensive Land use Evaluation for Construction Land. According to the existing research results analyze the related factors of land intensive use and some important land and economic indicators in urban planning and development, and finally determine the four dimensions of land input level, land use degree, land output level and land ecological benefit. Then collect the relevant important data [3, 4], and finally select 16 related index data as evaluation indicators. As show in Table 3.

| Aim | Factors | Index | Index Level | Unit                     |
|-----|---------|-------|-------------|--------------------------|
| Level of Intensive Land Use | Land Input Level | X1 | Average Investment in Fixed Assets of Construction Land | 10,000 RMB/Square Kilometer |
| Land Use Degree | X2 | Average Number of Stuff and Workers of Construction Land | Person/Square Kilometer |
| Land Input Level | X3 | Population Density | Person/Square Kilometer |
| Land Use Degree | X4 | Average Area of Built District of Construction Land | Square Kilometer |
| | X5 | Per Capita Construction Land Area | Square Meter/Person |
| | X6 | Per Capita Road Surface Area | Square Meter/Person |
| | X7 | Density of Road Network in Built District | Kilometer/Square Kilometer |
| | X8 | Per Capita Residential Land Area | Square Meter/Person |
| Land Output Level | X9 | Average GDP of Construction Land | 10,000 RMB/Kilometer |
| | X10 | Gross Industrial Output Value | 100 Million RMB |
| | X11 | Average Total Retail Sales of Consumer Goods of Construction Land | 10,000 RMB/Kilometer |
| | X12 | Average Government Revenue of Construction Land | 10,000 RMB/Kilometer |
| Land Ecological Benefit | X13 | Wastewater Treatment Rate | % |
| | X14 | Per Capita Green Space | Square Meter/Person |
| | X15 | Rate of Industrial Solid Wastes Comprehensively Utilized | % |
| | X16 | Energy Consumption of Ten Thousand Yuan Gross Domestic Product | Ton of Standard Coal |

The entropy method is used to calculate the weight value of all kinds of factors. Firstly, the obtained data are standardized by formula (1), in which \( x'_{ij} \) refers to the standardized value of i city j index, \( x_{ij} \) refers to the original value of i Prefecture-level city j index [5]. \( x_1 \) and \( x_{16} \) are negative indexes and the other indexes are positive indexes.

\[
X'_{ij} = \begin{cases} \frac{(X_{ij} - X_{j_{\text{min}}})}{(X_{j_{\text{max}}} - X_{j_{\text{min}}})} & X_{ij} \text{ is negative index} \\ \frac{(X_{j_{\text{max}}} - X_{ij})}{(X_{j_{\text{max}}} - X_{j_{\text{min}}})} & X_{ij} \text{ is positive index} \end{cases} \tag{1}
\]

In order to facilitate the calculation of weight value, the standardized value is adjusted by Tobit model [6] and formula (2).
\[ X_{ij} = \begin{cases} X_{ij}' & X_{ij}' > 0 \\ 0.001 & X_{ij}' \leq 0 \end{cases} \] (2)

Calculating the weight value of each index of the important year by using a normalized value through a formula (3) and a formula (4), where in \( d_j \) represents the redundancy of the indicator information of the year, and \( p_j \) represents the weight value of the index in the year, and \( m \) represents the number of the cities. The comprehensive weight value of each index and the weight of each factor as show in Table 4 are calculated by using the formula (5) and the formula (6). And \( p_{nj} \) represents the comprehensive weight, \( n \) represents the number of important years and \( e \) represents a factor layer.

\[ d_j = 1 + \frac{1}{\ln (m)} \sum_{i=1}^{m} \left[ X_i \times \ln (X_{ij}) \right] \] (3)

\[ p_j = \frac{\sum d_j}{\sum d_j} \] (4)

\[ p_{nj} = \frac{\sum p_j}{n} \] (5)

\[ p_e = \sum p_{nj} \quad (j \in e) \] (6)

**Table 4.** Weights of indicators and comprehensive weights of significance year in Hexi Corridor

| Factor          | Index                                                                 | 2013 Weight | 2015 Weight | 2017 Weight | Comprehensive Weight | Weight of Each Factor |
|-----------------|----------------------------------------------------------------------|-------------|-------------|-------------|----------------------|----------------------|
| **Land Input Level** | Average Investment in Fixed Assets of Construction Land | 0.058       | 0.059       | 0.055       | 0.057                | 0.123                |
|                  | Average Number of Stuff and Workers of Construction Land             | 0.066       | 0.067       | 0.066       | 0.066                |                      |
| **Land Use Degree** | Population Density                                                   | 0.065       | 0.065       | 0.063       | 0.064                |                      |
|                  | Average Area of Built District of Construction Land                  | 0.060       | 0.059       | 0.061       | 0.060                |                      |
|                  | Per Capita Construction Land Area                                    | 0.066       | 0.065       | 0.065       | 0.065                | 0.376                |
|                  | Per Capita Road Surface Area                                         | 0.061       | 0.059       | 0.060       | 0.060                |                      |
|                  | Density of Road Network in Built District                            | 0.059       | 0.060       | 0.065       | 0.061                |                      |
|                  | Per Capita Residential Land Area                                     | 0.065       | 0.066       | 0.063       | 0.065                |                      |
| **Land Output Level** | Average GDP of Construction Land                                     | 0.066       | 0.065       | 0.065       | 0.065                |                      |
|                  | Gross Industrial Output Value                                        | 0.063       | 0.062       | 0.061       | 0.062                |                      |
|                  | Average Total Retail Sales of Consumer Goods of Construction Land    | 0.065       | 0.067       | 0.066       | 0.066                | 0.259                |
|                  | Average Government Revenue of Construction Land                      | 0.066       | 0.066       | 0.065       | 0.065                |                      |
| **Land Ecological Benefit** | Wastewater Treatment Rate                                             | 0.060       | 0.058       | 0.064       | 0.061                |                      |
|                  | Per Capita Green Space                                               | 0.063       | 0.064       | 0.064       | 0.064                |                      |
|                  | Rate of Industrial Solid Wastes Comprehensively Utilized             | 0.059       | 0.060       | 0.059       | 0.059                | 0.242                |
|                  | Energy Consumption of Ten Thousand Yuan Gross Domestic Product        | 0.059       | 0.059       | 0.059       | 0.059                |                      |
Furthermore, the formula (7) is used to calculate the comprehensive score of land intensive use degree in each Refecture-level city in significance years as show in table 5, $w_i$ stand for the land intensive use score of year $i$ Refecture-level city.

$$W_i = 100 \times \sum (P_i \times X_{ij})$$  \hspace{1cm} (7)

| Year | Jiayuguan | Jinchang | Wuwei | Zhangye | Jiuquan |
|------|-----------|----------|--------|---------|---------|
| 2013 | 65.76     | 41.91    | 43.75  | 25.32   | 32.46   |
| 2015 | 62.71     | 39.50    | 52.06  | 23.97   | 38.24   |
| 2017 | 58.31     | 33.62    | 45.86  | 23.67   | 33.33   |

According to the classification of the comprehensive score of intensive land use by natural fracture method, the comprehensive score of 0~60 indicates extensive land use, 60~74 indicates low intensive land use, 74~86 indicates moderate intensive land use, and 86~100 indicates that land is highly intensive[7]. Generally speaking, in Hexi Corridor cities, only Jiayuguan has a low degree of intensive land use in 2013 and 2015, and the rest of the cities are extensive land use.

From 2013 to 2015, the comprehensive score of intensive land use of Wuwei and Jiuquan increased obviously, while the scores of other cities decreased. From 2015 to 2017, the comprehensive score of intensive land use of all prefecture-level cities in Hexi Corridor decreased. From 2013 to 2017, only Wuwei and Jiuquan cities have increased the degree of intensive land use, Jiayuguan, Jinchang and Zhangye have declined in the intensive degree of land use.

4. Conclusion and Countermeasure Prospects
In summary, from the point of view of land use intensive evaluation, only the intensive land use level of Wuwei and Jiuquan in the five prefecture-level cities of Hexi Corridor has increased slightly. In addition, Wuwei and Jiuquan (especially Dunhuang of Jiuquan) vigorously developed the cultural tourism industry with the help of historical and cultural elements, resulting in the leading proportion of the third production. The industrial pattern of three major industries is as follows (from large to small): tertiary industry, secondary industry, and primary industry. To a certain extent, the advantages of industrial pattern promote the intensification of land use. The land use structure of Wuwei and Jiuquan is more unified and reasonable than other cities, and only one kind of land proportion is outside the appropriate range. In this way, only comprehensive utilization and development of all kinds of land can we improve the efficiency of urban land output. The countermeasure prospects are as follows:

The first is to enhance the intensive use of land resources. From the evaluation results of land intensive profit, the degree of land intensive use in Hexi Corridor area is relatively extensive. It is suggested that the construction land should be reduced and the stock should be invigorated. Especially, after the industrial transformation of Jinchang and Jiayuguan, the reuse of industrial land and storage land as well as the change of land use nature should be paid great attention to. Wuwei and Zhangye should pay great attention to the intensive construction of residential land in order to avoid the disorderly expansion of land use and reduce the low-rise and low-density residential areas.

The second is to promote the development of the industry by means of cultural resources. Wuwei and Jiuquan develop the tertiary industry on the basis of culture, so they have absolute advantage industrial in three industrial structures. The land use structure is relatively reasonable and the land concentration degree is increasing. Other cities should actively excavate their own cultural resources and carry out to shape the city characteristics. Especially, Jinchang and Jiayuguan, which develop with the help of industrial development, should strengthen culture to lead the development, take the primary industry and secondary industry as the basis and the tertiary industries as the opportunity to drive the economic development, so as to shape Hexi area into a real cultural and economic corridor, and give full play to the historical mission and link role of Hexi Corridor.

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The third is to practice the green concept to promote efficient development. The wastewater treatment rate in Hexi Corridor reached more than 90%. However, the rate of industrial solid wastes comprehensively utilized in Jinchang and Jiuquan is still at a low level. It is suggested that cities should pay attention to environmental protection, strengthen the treatment and utilization of solid waste, continue to improve the treatment rate of sewage, increase the area of green space gradually, reduce energy consumption, adhere to the concept of green development, improve the living environment, shape the high quality natural ecological environment, combine the historical and cultural environment, and promote the economic efficiency and green development of Hexi Corridor.

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