

# Evaluation on Intensive Land Use in the Provincial Development Zones in Wuxi City, China

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**Abstract**-This paper deals with the intensive land use in the five provincial development zones in Wuxi, after constructing the evaluation index system from the viewpoint of present situation, efficiency and sustainability of land use, the paper calculates the weights using optimal combination of empowerment, and evaluates the intensity. The result shows that the land intensity difference is large in five development zones. The land intensity of Liyuan Park is the highest, up to 0.93, and that of Xishan, Shuofang and Wuxi Economic Development Zones is almost equal, respectively reaching 0.83, 0.81, and 0.80, while that of Huishan Economic Development Zone is the lowest, which is only 0.60. 147 enterprises were selected in Wuxi as samples standing for different manufactures to evaluate the land intensity among different manufacturing industries in this paper. This paper comes to conclusion that the intensity of the 11 manufacturing enterprises in Wuxi is much high.

**Key words**-Intensive land use; evaluation; Provincial Development Zones; Wuxi City

## I. INTRODUCTION

It is undeniable that there are several land-use issues in the construction and development process of development zones, such as land waste, inefficient land use, ecological environment quality decline, irrational land use structure, and lack of adequate understanding of living environment (Wang et al., 2004; Long et al., 2005). More and more Chinese scholars focused on the study of intensive land use. In a study of Baotou city in China, eight categories of representative industries were selected to construct land intensive utilization index system and evaluate land intensive utilization of industrial land (Zhen et al., 2004). In the study of Kunshan, some questionnaires of different industries, the result had supplied basis for industrial space adjustment (Wang, 2004). From the view of study methods, most scholars selected evaluation indicators according to the define in their study, evaluated the land use intensity and then put forward suggestions. In the present study, the researchers normally took such factors into consideration as land use efficiency, land use structure, input and output situation, land use management and so on (Yu et al., 2006; Li, 2008; NIU et al., 2007; Peng et al., 2008; Zhao et al., 2009).

## II STUDY AREA AND DATA SOURCE

### A. study area

Selecting Wuxi as a case study, this paper evaluated the situation of intensity of provincial development zones and the intensity of different industry departments in the Development Zones based on sample investigation of enterprises

In this paper, five provincial development zones in Wuxi City were selected to be the study cases (Figure 1), named as Xishan Economic Development Zone, Liyuan High-tech Industrial Park, Huishan Economic Development Zone, Wuxi Economic Development Zone, and Shuofang Industrial Park respectively.

### B. Data source

The number of qualified sample is 147, including 11 kinds of manufacturing industries, named the textile industry, chemical raw materials and chemical products manufacturing, rubber products, plastic products industry, fabricated metal products, general equipment manufacturing, special equipment land use in manufacturing, transportation equipment manufacturing, electrical machinery and equipment manufacturing, communication equipment, computers and other electronic equipment manufacturing, instrumentation and culture, office machinery manufacturing industry, etc. Land use situation is the average of enterprises based on excluding corporate abnormal value.

## III Methodology

### A. Indicators Selection

In this paper, we selected 13 indicators standing for land use structure, land use efficiency, land investment, land productivity and sustainability.

### B. Method of index Weights determination

The optimal combination between subjective weight (Hierarchy Process, AHP) and objective weight (Entropy Method) was introduced in this paper. Percentage of subjective and objective weight in multi-attribute decision-making problems were determined by establishing and solving a mathematical planning model in order to make sure that the weight can reflect objective willingness and objective incommensurate.

First, we use AHP method to determine the index weights. This model includes raw data standardization, hierarchy

model of indicators, all judgment matrix constructed in all levels, consistency test, calculation of weights and weighted composite of the criteria and index, and the importance of various elements in index layer.

Then, we use Entropy value method to determine the index weights Q as following formulas:

① Proportion of  $j$  indicator in  $i$  region calculation  $r_{ij}$  :

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^n x_{ij}}, \quad i=1,2,\dots,n; \quad j=1,2,\dots,m \quad (1)$$

② Entropy calculation of  $j$  indicator  $h_j$  :

$$h_j = -\sum_{i=1}^n r_{ij} \frac{\ln r_{ij}}{\ln n}, \quad j=1,2,\dots,m \quad (2)$$

③ Difference coefficient calculation of  $j$  indicator  $g_j$  :

$$g_j = 1 - h_j, \quad j=1,2,\dots,m \quad (3)$$

④ Weight calculation of each index  $w_j$  :

$$w_j = \frac{g_j}{\sum_{j=1}^m g_j}, \quad j=1,2,\dots,m \quad (4)$$

In the end, we determined Index weights by the optimal combination weighting method.

Provided the optimum combination of the weight coefficient is  $W_c = (W_{c1} \ W_{c2} \ \dots \ W_{cm})^T$ , and order:  $W_c = k_1 W_1 + k_2 W_2$ . Where  $k_1, k_2$  is the linear expressed coefficient of the combined weights coefficient vector. And  $k_1, k_2$  are both greater equal 0 and satisfy the unit constraint condition:  $k_1^2 + k_2^2 = 1$ . Obviously, the key issue of optimal combination weighting approach is the confirmation of  $k_1, k_2$ .

Multi-index comprehensive evaluation of the decision-making program was calculated by the formula

$$y_i = \sum_{j=1}^m w_j x_{ij}, \quad i=1,2,\dots,n, \text{ based on a simple weighted}$$

method. Obviously, the larger  $y_i$  is, the more intensive land use in the Region  $i$  is.

In the land intensive use evaluation, a possible difference will be existed in every comprehensive evaluation value in each area, i.e., comprehensive evaluation value dispersed as much as possible.

So, linear function named  $y = \sum_{i=1}^m b_i x_i$  was set as

comprehensive evaluation function. And the question becomes: determining  $\lambda_1, \lambda_2$ , and makes

$$\sum_{i=1}^n (y_i - y)^2 = \sum_{i=1}^n \left( \sum_{j=1}^m (k_1 p_j + k_2 q_j) x_{ij} - y \right)^2 \quad \text{have}$$

the maximum value. Because  $y$  equals 0 in the normalization process of the original data, the maximum

$$\text{value of } \sum_{i=1}^n y_i^2 = \sum_{i=1}^n \left( \sum_{j=1}^m (k_1 p_j + k_2 q_j) x_{ij} \right)^2 \quad \text{will be}$$

acquired under the constraint conditions " $k_1^2 + k_2^2 = 1, k_1, k_2 \geq 0$ ".

The optimization model was solved by Matlab software, after running the program, acquiring K the value of W was calculated finally.

## IV RESULTS

### A. weight determination of 5 development zones

According to methods introduced in former study, weight was determined by entropy method on the basis of the data processing. And the weight of Analytic Hierarchy Process (AHP) method was determined after integrating views of experts. Finally, two weights were optimal combination, and got  $k=0.612$ .

### B. result of land use intensity

Land use intensity varies a lot among five development zones. The land use intensity of Liyuan High-tech Industrial Park is the highest, reaching 0.93 while Huishan Economic Development Zone is the lowest, only reaching 0.60, which is 0.33 lower than Liyuan High-tech Industrial Park. As for Xishan Economic Development Zone, Shuofang Industrial Park, and Wuxi Economic Development Zone, land use intensity are almost the same with value 0.83, 0.81, 0.80 respectively (Figure 2).

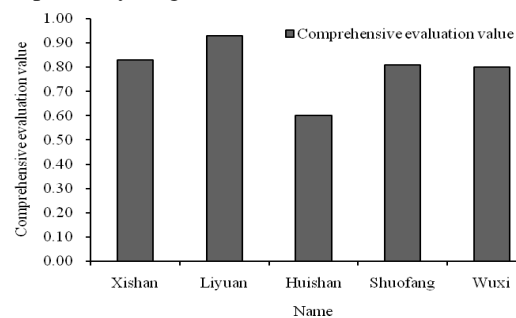


Figure 2 Land intensive use comprehensive degree of five provincial level economic development zones, Wuxi City

### C. Assessment of land use structure

The proportion between the total land area and the administrative office and living service area in the textile

industry is 8.30%, which is higher than the national standard. The percentage in transportation equipment manufacturing (6.89%) and chemical raw materials and chemical product manufacturing (6.77%), is slightly higher than state-controlled standard. And percentage of the other industries keeps state-controlled standard.

#### D. evaluation of land use intensity

The volume rate of plastic products industry is 0.90, which does not reach the state-controlled standard while volume rates of the other industries have all reached state-controlled standard. Building density levels of 11 industries all reached state-controlled standard. Land use intensity of the plastic products industry and communications equipment, computers and other electronic equipment manufacturing is higher, which significantly exceed the controlled standard. Land use intensity of some manufacturing industries is relatively lower, due to characteristics of the industry and the presence land of development.

#### E. Input-Output evaluation

The overall level of input-output in 11 manufacturing industries is higher, which all exceed the state controlled indicators (Figure 3, Figure 4). Investment ratio of rubber products industry is the highest, which has reached 1.83 times of state-controlled standard, and plastic products industry is the lowest, only has reached 1.16 times of state-controlled standard. Output ratio of rubber products industry is the highest, which has reached 3.99 times of the Shanghai controlled standard, while chemical raw materials and chemical products manufacturing is the lowest, which is only 1.25 times of the Shanghai controlled standard<sup>1</sup>.

### V CONCLUSIONS

This paper dealt with land use situation of 11 manufacturing industries by investigation of typical enterprises in five development zones, and comprehensive evaluation of land intensive use was implemented. The results show that land intensive use level of electrical machinery and equipment manufacturing are more than 0.8, the land use intensity of transportation equipment manufacturing, general equipment manufacturing and communications equipment, computers and other electronic equipment manufacturing are more than 0.75. And the comprehensive intensity of rubber products is more than 0.7, the following is special equipment manufacturing and instrumentation and culture, office machinery manufacturing industry, which are more than 0.6, while land use intensity of plastic products, fabricated metal products, textiles and chemical materials and chemical products manufacturing level are relatively low, less than 0.6.

#### ACKNOWLEDGMENT

Thanks for the support of national natural sciences foundation of China (NO.41130750 and NO.40971072).

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<sup>1</sup> Data is from Shanghai Industrial Land Guide(2008)

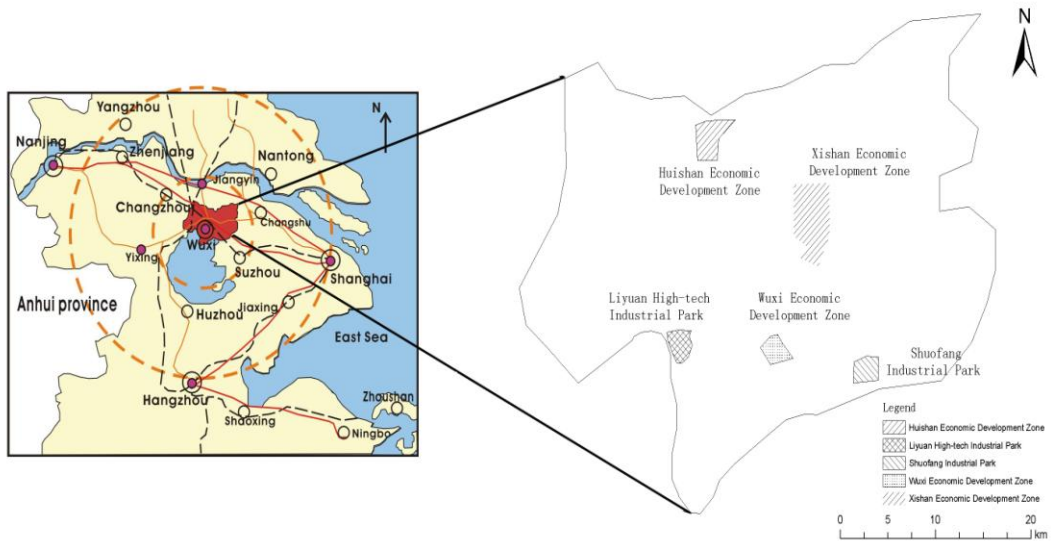


Figure 1 Location of five Provincial Development Zones in Wuxi

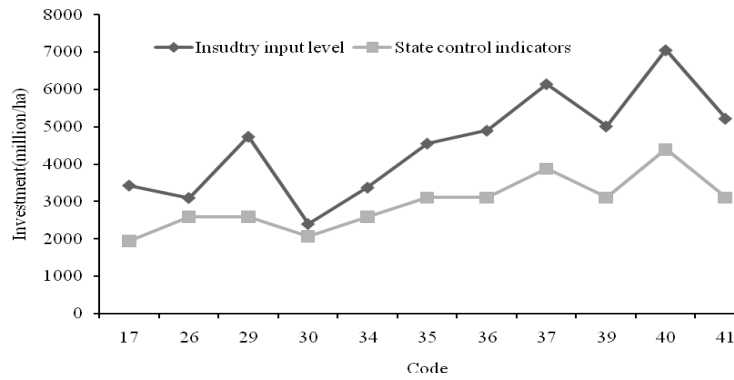


Figure 3 Analysis of input per unit in the 5 provincial development zones in Wuxi

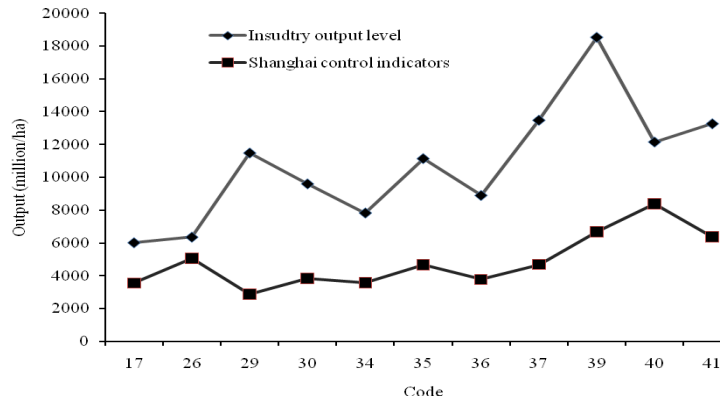


Figure 4 Analysis of input per unit in the 5 provincial development zones in Wuxi