

# Study on Synthesis Evaluation of Intensive Land Use and Growth Pattern Transformation of Towns

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**Abstract**—It is very important that the scientific and reasonable evaluation on the intensive utilization of urban land and transformation of growth modes. It can enhance the levels of consolidation and management for urban land, maximize the intensive use efficiency of the land, and ensure sustainable development. In order to construct the comprehensive evaluation index system of the intensive utilization of urban land and transformation of growth modes. First, meet the the principles of scientificity, comparability and measurability, moderation, level, fairness and the goal-orientation. Second, consider the economic, social and ecological benefits from intensive utilization of land. Third, must be from the perspective of transforming the growth mode. Determine the weight coefficient of the evaluation indexes through weight determining method. The method is a combination of the AHP model supported by entropy technology and quantitative transformation of qualitative indexes supported by democratic decision-making of experts group. Then, apply fuzzy membership function method to conduct quantizing process for evaluated indexes. On this basis, build multi-target multi-level fuzzy comprehensive measuring model what is based on index system, use this model to calculate the value of comprehensive evaluation index. Take the new Zone of Northern Haidian District in Beijing as an example, and conduct a comprehensive evaluation research. The evaluation results indicate that the current intensive utilization level of urban land in Northern New Zone is low, which mainly reflected in the indexes of the water and soil resource utilization and ecological environment are not high. Therefore, further change of the growth mode should be made in the future so as to improve the intensive utilization level of land.

**Index Terms**—intensive land use; transformation of growth modes; town

## I. INTRODUCTION

Intensive land use is the inevitable requirement under the development of circular economy and construction of conservation-oriented society [1]. For the prominent contradictions and problems occurred during economic operation, the central leadership has repeatedly stressed

that utilize the land economically and intensively and effectively protect cultivated land, especially basic farmland according to the requirements of building a conservation-oriented society and developing circular economy [2-4]. *The Main Points of Land and Resources in 2007* considered and passed by the Ministry of Land and Resources has also clearly stated that "vigorously promote to use the land economically and intensively. ... Establish evaluation system and assessing system of economical and intensive utilization of land and conduct strict supervision and assessment. Conscientiously summarize and promote new experience of utilizing the land economically and intensively." [5-6] At present, issues of intensive land use in large and medium-sized cities in China have obtained common concern but problems of utilization and management of land in small cities especially small town should not be overlooked as well: the rapid growth in urban land utilization, inefficient utilization of land, random changes in land use, irrational land use structure, large defects in land management system and unreasonable income distribution, etc [7-10]. In recent years, scholars have carried out researches on intensive utilization of urban land, but the relevant research is still at the exploratory stage, facing a series of new problems and new directions. In order to better guide the town healthy, orderly and harmonious development, it is necessary to establish a set of comprehensive evaluation index systems and methods to evaluate the intensive utilization of land and transformation of growth modes that are in line with the characteristics of small cities or small towns. Up to now, researches on evaluation of intensive utilization of domestic urban land are still at a preliminary stage; evaluation methods lack supports of systematic theories and methods; the evaluation systems are mostly one-way indexes and qualitative indexes, few of comprehensive and multi-factor indexes, a unified authoritative index system is yet to be formed [11-14]. In view of the above-mentioned situations, this paper applies more systematic and mature evaluation methods and models to build a comprehensive, multi-factor evaluation index system,

from the perspective of the transformation of the growth modes, conduct a comprehensive analysis and evaluation for problems of intensive utilization of urban land in China, with a hope to make up the deficiencies in researches on these aspects and promote management departments with dynamic and effective management for intensive utilization of urban land in practice.

## II. COMPREHENSIVE EVALUATION INDEX SYSTEMS

### A. Principles of Building Comprehensive Evaluation Index Systems

From the view of the dual objectives that guide the urban sustainable development and sustainable management, this paper, guided by scientific concept of development, construct the comprehensive evaluation index systems for the purposes of building the towns into new ones with prominent features, reasonable division of work, economic prosperity, environmental friendly, efficient management, civilization and harmony [15-18]. The selection of index system insists on principles like scientificity, comparability and measurability, moderation, level, fairness and the goal-orientation. The specific ideas are: (1) First, select the objects involved in the evaluation and assessment; (2) try to set the evaluation index systems with combination of each town's development orientation and positioning of each town from the perspective of regional development; (3) evaluation index systems should reflect the differences in development of various towns in the same district, and differences in different function Zones like urban function expanding Zones, ecological function protecting Zones, urban agricultural Zones; (4) the selection of evaluation index should take full account of the land usage structure changes in the town, the type of land usage including the cultivated land, garden, woodland, grassland, construction land and others; (5) recommend to establish four-level evaluation indexes, of which the fourth level evaluation indexes are generally not more than 20; (6) evaluation index systems should focus on indexes of harmonious development of society and ecology while concerning on the economic benefits from intensive utilization of urban land ; (7) obtain data of the involved evaluation index, and unify the statistical data.

### B. The Basic Frameworks of Comprehensive Evaluation Index Systems

This paper applies progressive factor analysis to establish comprehensive evaluation index system for intensive utilization of urban land and transformation of growth modes. The so-called progressive factor analysis means to explain "factor indexes" to "to be interpreted indexes" at different levels [19-20]. Based on the above selected basic ideas of comprehensive evaluation index systems, and with reference to evaluation systems of the urban land sustainable development established by relevant domestic and international researches, combined with urban land use study Zone , and ease of access based on indicators and a new statistical utilization characteristics of land in cities and towns, and situation of

different difficulty in obtaining the indexes and index changes in new statistical method; after integrated balance, this paper defines the basic frameworks of comprehensive evaluation index systems for intensive utilization of urban land and transformation of growth modes into 4 second-level indexes, 19 third-level indexes, and around 90 fourth-level indexes.

According to progressive factor method, second-level index is actually the interpretation of the evaluation targets. Therefore, the above construction of comprehensive evaluation index system includes both level measurement of the intensive utilization of land and the indexes reflecting the transformation of growth modes. Combined with the development characteristics of small towns, especially designed the evaluation indexes of social harmonious development and eco-friendly development for evaluation of the growth modes transformation [21-24]. Attempt to combine with other indexes so as to reflect the original ambiguous "transformation of growth modes" in concept from different aspects, and better reflect strategic requirements of building resource-saving, environment-friendly and harmonious society.

## III. EVALUATION MODEL AND METHOD

Based on the above established index systems, before comprehensively evaluate intensive utilization of urban land and transformation of growth modes, there needs to solve two key problems: the first is to determine the weight coefficient of various index in the evaluation system scientifically, this paper uses the AHP model under entropy technical support, to figure out 1 to 3-level index weight coefficient, uses the weight determining method of quantitative transformation of qualitative indexes supported by democratic decision-making of experts group, to figure out the four-level index weight coefficient relative to the total goal; the second is to scientifically carry through the index dimensionless processing, considering there are both forward index and reverse index in evaluation indexes system, "good" or "bad" between the indexes is with fuzziness in a great extent, therefore, adopt the fuzzy membership function method to quantify each index "value". On this basis, finally use multi-level multi-target fuzzy comprehensive evaluation model to comprehensively measure and calculate evaluation indexes of the intensive utilization of urban land and transformation of growth modes.

### A. Evaluation Model

AHP method put forward by American operations research expert A . L. Saaty, is a kind of decision analysis techniques of combination of qualitative and quantitative, is to resolve the complex problem to be identified into a number of levels (assuming from up to down divided into A, B, C, D four levels), which will be judged and scored on the listed index by experts and policy makers through the comparison of important degree between each two of them, statistical processing the score results to construct judgment matrix  $R = \{r_{ij}\}_{m \times n}(i, j = 1, 2, \dots, n)$  , using the formula  $RW = \lambda \max W$  to calculate the matrix R

characteristic root and characteristic vector, in order to determine contribution degree of the lower level index to upper level index, and according to the formula  $CI = (\lambda \max - n) / n - 1$  to test and judge the consistency of the matrix, when the judgment matrix random consistency ratio  $CR = CI / RI < 0.10$ , it is determined that the judgment matrix is with satisfactory consistency. AHP technology to identify problems is with strong systematicness and relatively high reliability, but when using expert consultation method, it is easy to produce axioms which circulates and does not satisfy transitivity, which leads to problems like inaccurate scale and missing part information, the effective way to solve these problems is to use entropy technology to amend the weight coefficients determined by AHP method.

**B. Weight Determining Method**

When the chosen layout index number is too much, we can adopt weight determining method of quantitative transformation of qualitative indexes supported by democratic decision-making of experts group, which is easy to interpose for experts, simple in form, convenient in processing and relatively objective, to determine each specific index weight coefficient of the D level. Then distribute the weight coefficient of C level evaluation index relative to the total goal A to the D level index in proportion, and get the weight coefficient of D level each specific each index relative to the A level. The basic principle is as follows:

Assume a evaluation and prediction problem has a total of  $M$  specific indexes,  $n$  experts independently judge and sort the  $M$  evaluation indexes, get order matrix  $F = \{f_{ij}\}_{m \times n} (i = 1, 2, \dots, m; j = 1, 2, \dots, n)$ , by  $F$  matrix according to the formula  $h_{ij} = m + n - f_{ij} (1 \leq f_{ij} \leq m)$  to construct priority matrix  $H = \{h_{ij}\}_{m \times n} (i = 1, 2, \dots, m; j = 1, 2, \dots, n)$ , by the priority matrix  $H$ , according to priority number and method, priority number rad method and priority number logarithmic method to get evaluation index weight coefficient [16], among which the priority number logarithm method computation formula is as follows: (1)

$$W_i = \frac{\sum_{j=1}^n \ln h_{ij} / \ln(q-1)}{\sum_{i=1}^m \sum_{j=1}^n \ln h_{ij} / \ln(q-1)} = \frac{\sum_{i=1}^n \ln h_{ij}}{\sum_{i=1}^m \sum_{j=1}^n \ln h_{ij}} = \frac{\ln \prod_{j=1}^n h_{ij}}{\sum_{i=1}^m \ln \prod_{j=1}^n h_{ij}} \quad (1)$$

**C. Fuzzy Membership Function Model**

In the process of quantify the evaluation indexes, for the positive index, use half rise trapezoid fuzzy membership functions, namely: (2)

$$\Phi_{(e_{ij})} = \frac{e_{ij} - m_{ij}}{M_{ij} - m_{ij}} = \begin{cases} 1 & e_{ij} \geq M_{ij} \\ \frac{e_{ij} - m_{ij}}{M_{ij} - m_{ij}} & m_{ij} < e_{ij} < M_{ij} \\ 0 & e_{ij} \leq m_{ij} \end{cases} \quad (2)$$

For the converse index, use half drop trapezoid fuzzy membership functions, namely: in the formula (3):

$$\Phi_{(e_{ij})} = \frac{M_{ij} - e_{ij}}{M_{ij} - m_{ij}} = \begin{cases} 1 & e_{ij} \leq m_{ij} \\ \frac{M_{ij} - e_{ij}}{M_{ij} - m_{ij}} & m_{ij} < e_{ij} < M_{ij} \\ 0 & e_{ij} \geq M_{ij} \end{cases} \quad (3)$$

$e_{ij}$  is specific property value of the indexes,  $i = 1, 2, \dots, m$ , represents the number of towns;  $j = 1, 2, \dots, n$ , represents the  $i$  th towns index number;  $M_{ij}$  and  $m_{ij}$  respectively represent the maximum value and minimum value of the  $i$  th index property value in the same period of different interval;  $\Phi(e_{ij})$  represents index membership degree, its value is between 0 - 1.

**D. Multi-level and Multi-target Fuzzy Comprehensive Measuring Model**

Based on frameworks of the evaluation index system, set the township set to be determined as  $U = \{U_1, U_2, \dots, U_m\}$ ; measuring target set as  $B = \{B_1, B_2, \dots, B_q\}$ ; and composed by the  $t$  sub-goals, denoted as  $B_i = \{C_{i1}, C_{i2}, \dots, C_{in}\}$ ; index set consists of all measuring indexes as  $C$ , based on  $n$  sets can not divide targets, divide  $C$  into  $n$  sub-sets as  $C_i (i = 1, 2, \dots, n)$ , assume the  $i$  th sub-set  $C_i$  has  $h$  measuring indexes. First, assume the weight coefficient vectors of  $h$  measuring indexes in sub-set of  $C_i$  are:  $A(i) = (a_1(i), a_2(i), \dots, a_n(i))$ , of which, the value of  $a_k(i)$  applies equation (1) for calculation; Second, build  $m$  measurement Zone of index set  $C$  corresponding to the  $h \times n$  measuring indexes of  $h \times n \times m$  attribute values matrix, and use the formula (2) and (3) to make the index property value matrix into measure membership matrix  $R(i)$ . After finding  $R(i)$  and  $A(i)$ , the  $C_i \times U$  can be obtained by the fuzzy comprehensive measure set  $E(i)$ :

$$E(i) = \underline{A}(i) \cdot \underline{R}(i) = (e_1(i), e_2(i), \dots, e_m(i)) \quad (4)$$

where,  $e_j(i)$  is the fuzzy comprehensive measure result of  $U_j \in U$  in  $C_i \times U$  Zone, under situation of fully considering the various factors, its value can be calculated according to the formula (5) calculation:

$$e_j(i) = \sum_{k=1}^h [a_k(i) \cdot r_{kj}(i)] \quad j = 1, 2, \dots, m \quad (5)$$

the calculated  $E(i)$  as a higher level measurement of matrix rows, and then according to the higher level's characteristics and their the weight coefficient vectors, and with the reference of model calculation corresponding to the selected evaluation principles, a more higher level fuzzy comprehensive measure set can be obtained. Like this, start evaluation from the lowest level, and gradually rise to the highest level, the final comprehensive measure result set  $E$ : (6) can be obtained.

$$E = \underline{A}(i) \cdot \underline{R}(i) = (e_1, e_2, \dots, e_m) \quad (6)$$

Make the Equation (6) in  $e_j(j=1,2,\dots,m)$  in descending order, so the comprehensive level status of intensive utilization of land and transformation of growth modes in different towns in the evaluated Zones can be obtained.

IV. COMPREHENSIVE EVALUATIONS OF INTENSIVE UTILIZATION OF URBAN LAND AND TRANSFORMATION OF GROWTH MODES IN NORTHERN NEW ZONE OF HAIDING DISTRICT, BEIJING

With the large-scale land expansion for urban construction in Beijing, urban land resource supply is under tense situation. As one of the important construction districts in Beijing, Haidian has become a region lack of land resource for the present. With Baiwang Mountain as a boundary, Haidian is divided into two parts by the mountain. The Zone behind the mountain is called North New Zone. The Zones involved in the evaluation in North New Zone including four towns. That is Wenquan town, Sujiatuo town, Shangzhuang town and Xibeiwang town. North New Zone is not only a strategic hinterland in Haidian for future development, but also a traditional rural Zone. The natural landform of "a mountain with water by its three sides" and geographical location of "windward and upriver" which are formed by Xishan and the approach channel from the Nanshan River, Beisha River and Jingmi River, which make this Zone a unique "Good Landscape Geomancy" in Beijing. This Zone covers an area of about 226 square kilometers, equivalent to 53% of the total Zone of Haidian. There is a total population of 195,600 in the Zone, accounting for 7.8% of population in Haidian District. The resident population density is 865 persons per square kilometer, accounting for only 15.4% of population density in Haidian District. In 2004, the total GDP gross of the four towns in Northern New Zone reaches 21.2 billion yuan, with GDP per square kilometer on average less than a thousand million. Compared to the average level of Haidian District, the gap is large. Therefore, it is urgently needed to further change the land utilization status to improve the intensive utilization of land regardless of low economic density and low population density in North New Zone of Haidian District.

A. Establishment of the Comprehensive Evaluation Index System and the Processing of Data

During the process of field research and data collecting in North New Zone of Haidian District, it indicates there are still no statistical data for some indexes. There is little comparative value among the four towns due to non-uniform of statistic data for some indexes. Therefore, based on the above comprehensive evaluation index systems, it removes parts of the indexes on condition that there is little impact on the evaluation results and finally the comprehensive evaluation index system consists of 4 second-level indexes, 15 third-level indexes, and 66 fourth-level indexes and build original data table of evaluation indexes. On this basis, we can find out two to four grade index weight coefficients using the AHP mode under entropy technical support and weight determining

method of quantitative transformation of qualitative indexes supported by democratic decision-making of experts group. Then we can quantify the value of each index by the use of fuzzy membership function to get the fuzzy membership function value.

B. Evaluation Results and Analysis

Using the evaluation index weight coefficient and fuzzy membership functional value calculated by the above mentioned calculation and adopting multi-level as well as multi-target fuzzy comprehensive measuring model to calculate step by step, a comprehensive measuring value for the first-level, second-level and third-level evaluation indexes for intensive utilization of land and transformation of growth modes in Northern New Zone can be finally worked out.

Comprehensive evaluation results analysis and rankings for towns' harmonious economy development in Northern New Zone.

It can be concluded that Xibeiwang town has obvious advantage in aspect of economic gross index. The gaps of economic structure indexes among the four towns are considerably small. In aspect of economic benefit index, Wenquan town and Xibeiwang town have obvious advantages over other two towns. Benefit index of Wenquan town is the highest, reaching 0.3, while that of Sujiatuo town is less than 0.01(Figure.1). As a whole, the

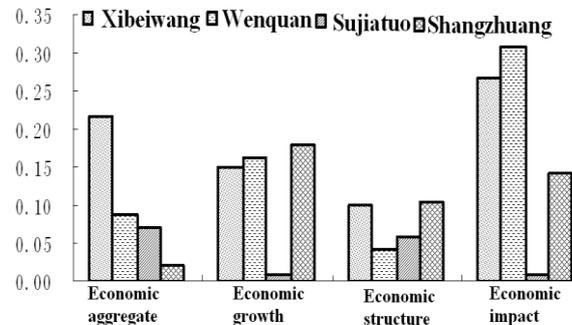


Fig.1 Column graph of subordinate index of economy harmonious development

comprehensive index for economy harmonious development in Xibeiwang town is the highest in Northern New District, Wenquan town taking the second place, Shangzhuang town coming next and that of Sujiatuo town being the lowest (Figure.2).

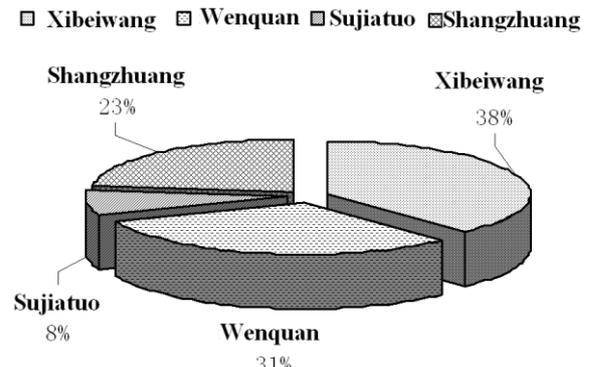


Fig.2 Pie graph of synthetic indicator of economy harmonious development

Comprehensive evaluation result analysis and rankings for intensive utilization of land and water resources in towns of Northern New Zone

Comprehensive evaluation for intensive utilization of land and water resources in towns of Northern New Zone and the exponential values of its sub-indexes acquired by calculation can be found in Table 1. It can be concluded

TABLE I.  
THE EVALUATION RESULTS OF SYNTHETICAL INDEX AND SUBORDINATE INDEX ABOUT WATER AND LAND INTENSIVE USE OF TOWNS IN NORTH NEW AREA

Index	Xibeiwang	Wenquan	Sujiatuo	Shangzhuang
Economical use of water resources	0.0764	0.0139	0.0834	0.0145
Economical use of energy	0.0345	0.0467	0.0285	0.0000
Total land use	0.0329	0.0267	0.1500	0.0100
Into the extent of land use	0.1500	0.0768	0.0000	0.0300
Land use intensity	0.0600	0.0559	0.1020	0.0315
Intensive land use efficiency	0.1748	0.2500	0.0000	0.0150
Intensive land use structure	0.0834	0.0078	0.0940	0.0364
Intensive use of land and water resources	0.6119	0.4777	0.4579	0.1374

by analyzing the table that intensive utilization indexes of Sujiatuo town and Xibeiwang town are higher in aspect of intensive utilization of water resource, while those of Wenquan town and Shangzhuang town are lower. Wenquan town has the highest energy intensive utilization index, Xibeiwang town taking the second place, Sujiatuo town coming the next while that of Shangzhuang town being almost zero. Analyzing the intensive utilization of land resource of each town, total amount of that in Sujiatuo town is distinctively higher than those in other three towns and that of Shangzhuang town is the lowest. As for investment degree, that of Xibeiwang town is the highest, Wenquan town taking the second place, while the land utilization investment degree index of Sujiatuo town being almost zero. In aspect of Land utilization strength, that of Sujiatuo town is higher than those of other three towns; Wenquan town has the highest land intensive utilization index, Xibeiwang town taking the second place and Sujiatuo town being the lowest. Land intensive utilization structure index of Sujiatuo town is slightly higher than that of Xibeiwang town, Shangzhuang town coming the next and that of Wenquan town being the lowest. Analyzing the comprehensive index for intensive

utilization of land and water resource, energy intensive utilization degree in Xibeiwang town is the highest, Wenquan town and Sujiatuo town coming the next and effect of land and water utilization in Shangzhuang town being the worst (Figure.3).

▣ Xibeiwang ▣ Wenquan ▣ Sujiatuo ▣ Shangzhuang

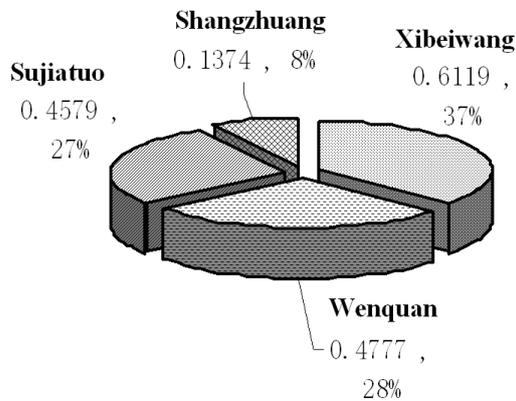


Figure 3. Pie graph of synthetical indicator of water and land intensive use.

Comprehensive evaluation results analysis of social harmonious development in cities and towns in Northern New Zone as well as the ranking.

Comprehensive evaluation of social harmonious development in administrative region of each town and the exponential values of its sub-indexes acquired by calculation can be found in Table 2. It can be concluded that Xibeiwang town has the highest exponential value of

TABLE II.  
THE EVALUATION RESULTS OF SYNTHETICAL INDEX AND SUBORDINATE INDEX AND SEQUENCE ABOUT SOCIETY HARMONIOUS DEVELOPMENT OF TOWNS IN NORTH NEW AREA

Index		Xibeiwang	Wenquan	Sujiatuo	Shangzhuang
Population quality	Index	0.3338	0.2402	0.0692	0.0074
	sequence	1	2	3	4
Social Security	Index	0.1984	0.1682	0.1736	0.1813
	sequence	1	4	3	2
Investment Environment	Index	0.1800	0.1484	0.0419	0.0500
	sequence	1	2	4	3
Harmonious development of society	Index	0.7122	0.5569	0.2848	0.2387
	sequence	1	2	3	4

population quality index, Wenquan town taking the second place, that of Sujiatuo town being lower and that of Shangzhuang town being the lowest. By analyzing social security index, it can be concluded that the indexes of the towns are almost the same, that of Xibeiwang town being slightly higher than those of other three towns. By analyzing investment environment index, it can be concluded that the index of Xibeiwang town is the highest, Wenquan town taking the second place while those of Shangzhuang town and Sujiatuo town are lower (Figure.4). In conclusion, the comprehensive evaluation

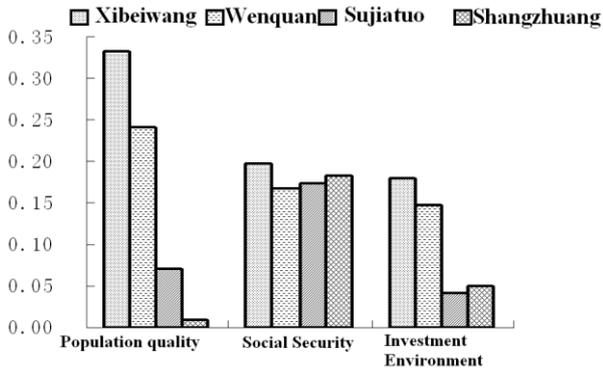


Fig.4 Column graph of subordinate index of society harmonious development

index of social harmonious development in Xibeiwang town is the highest, Wenquan town taking the second place and Sujiatuo town and Shangzhuang town being lower (Figure.5).

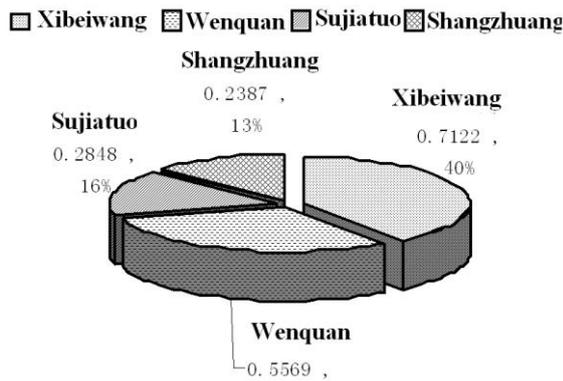


Fig.5Pie graph of synthetical indicator of society harmonious development

Comprehensive evaluation for eco-friendly situation in towns of Northern New Zone.

Due to information limitation, only a sub-index representative, index of ecology suitability (Table 3), is adopted for eco-friendly situation in towns of Northern New Zone. Among the four towns, the ecology suitability index of Sujiatuo town is obviously higher than that of other three towns, Wenquan town ranking the next, Shangzhuang town taking the third place and Xibeiwang town is the lowest (Figure.6). Therefore, attention shall be paid not only to strengthening economic growth but also to eco-environmental protection.

TABLE III. THE EVALUATION RESULTS OF SYNTHETICAL INDEX ABOUT ENVIRONMENT AMITY STATUS OF TOWNS IN NORTH NEW AREA

Town	Xibeiwang	Wenquan	Sujiatuo	Shangzhuang
Ecological suitability index	0.0870	0.6000	0.9793	0.4325

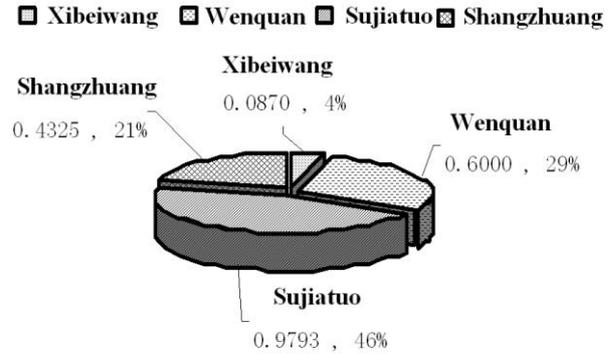


Fig.6 Pie graph of synthetical indicator of environment amity status

TABLE IV. VALUES OF THE SECOND AND FIRST LEVEL EVALUATION INDEX AND SEQUENCE OF INTENSIVE LAND USE AND GROWTH PATTERN TRANSFORMATION IN TOWNS IN NORTH NEW AREA

Index		Xibeiwang	Wenquan	Sujiatuo	Shangzhuang
Coordinated economic development	Index	0.7330	0.6002	0.1468	0.4453
	sequence	1	2	4	3
Intensive use of resources	Index	0.6119	0.4777	0.4579	0.1374
	sequence	1	2	3	4
Harmonious development of society	Index	0.7122	0.5569	0.2848	0.2387
	sequence	1	2	3	4
Eco-Friendly	Index	0.0870	0.6000	0.9793	0.4325
	sequence	4	2	1	3
Comprehensive measure	Index	0.6258	0.5505	0.3648	0.2897
	sequence	1	2	3	4

General results of comprehensive evaluation for intensive utilization of land and transformation of growth modes in towns of Northern New Zone in Haidian

District(Table 4) is as follows: The comprehensive evaluation index of Xibeiwang town is the highest, Wequan town ranking the next, Sujiatuo town taking the third place and Shangzhuang town coming the last(Figure.7). Analyzing the four second-level indexes, a conclusion can be made that the advantages of Xibeiwang town lie in that its indexes of economy coordinated development, social harmonious development and intensive utilization of the

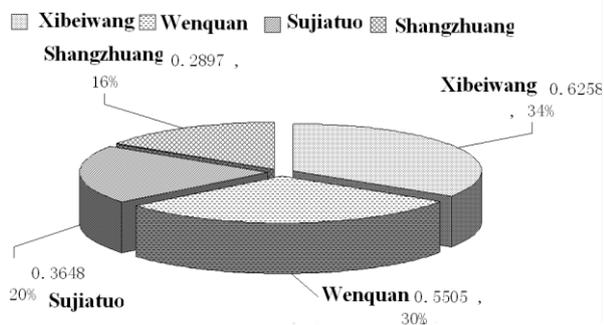


Fig.7Pie graph of synthetical indicator of intensive land use and growth pattern transformation in towns in North New Area

land and water resources are pretty high while the disadvantage is that its eco-friendly index is lower, ranking behind those of other three towns(Figure.8), which has a close relation to the real situation that the quality of ecological environment has been obviously decreased as that town has been ceaselessly occupying farm land and ecological land for construction use. In the future, therefore, importance shall be attached to the protection of farm land and ecological land to improve the quality of ecological environment. As one of six key developing towns in Beijing, Wenquan town has higher evaluation indexes in aspects of economy, society, resources and environment etc. (Figure.8), playing a typical demonstration role in small town construction in

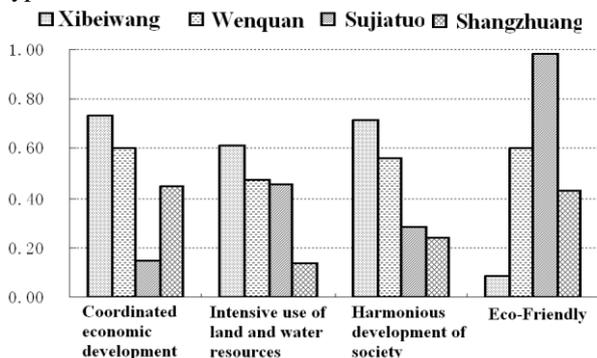


Fig.8 Column graph of the second grade evaluation index values of intensive land use and growth pattern transformation in towns in North New Area

the whole city. With the tendency of increasingly mercerization on land development, however, Wenquan town will pay much attention to the issue of land intensive utilization and transformation of growth modes during the process of urbanization. Suajiatuo town is located at the Zone with the best environment in Northern New Zone, with Jingmi Grand Canal going through the town Zone from north to south. Except for its ecological

environment index, however, its other three indexes all rank the last of the four towns (Figure.8). Therefore, we shall make the best of environmental advantage to blend in the ceaselessly expanding Beijing urban economic zone as soon as possible, with ecological tourism as the leading industry and high technology industries as the support. Among the four towns, all evaluation indexes of Shangzhuang town are not very high (Figure.8), therefore it shall not only speed up the process of upgrading its industrial structure and improving its economic effect but also protect the wetland ecological environment in administrative region of the town to construct it into a new town with harmonious development in aspects of economy, society, resources and environment as soon as possible.

V. CONCLUSION AND DISCUSSION

In this paper through building comprehensive evaluation index system including evaluation indexes of economic coordination, resource intensiveness, social harmony and environment friendly aspects, combined with the AHP model under entropy technical support and weight determining method of quantitative transformation of qualitative indexes supported by democratic decision-making of experts group to determine the weight coefficient of evaluation index; apply fuzzy membership function method to conduct quantizing process for evaluated indexes; use multi-target multi-level fuzzy comprehensive evaluation model to measure the comprehensive evaluation index value; and practical analysis of towns in the Northern New Zone in Haidian District. Evaluation results are basically consistent with the actual situation, which shows that the constructed comprehensive evaluation index system and the applied models, methods are with strong scientific applicability and effectiveness.

Based on evaluation results, the current intensive utilization level of urban land in Northern New Zone, Haidian District, is relatively low, which is reflected from that the indexes of economic coordination, resource intensiveness, social harmony and ecological environment are not high, and intensive utilization degree of land in various towns is quite different. Compared with the four towns, comprehensive evaluation index of the Xibeiwang town is the highest, followed by Wenquan town and Sujiatuo town, and finally the Shangzhuang town. Among them, the Xibeiwang town's indexes of economic coordination, social harmony and the intensive utilization of land and water resources are higher but eco-friendly index is low; Wenquan town's indexes of economy, society, resources, environment and other aspects are relatively high; as for Sujiatuo town, except its eco-friendly index is high, the remaining three evaluation indexes are the lowest of the four towns; the evaluation index values of Shangzhuang town are not high, the comprehensive evaluation index is the lowest among the four towns.

To facilitate realizing the rolling management of intensive utilization level of urban land in Northern New

Zone, this article suggests: (1) through authorizing by the government, compile urban statistics report according to standardized comprehensive evaluation indexes; (2) reasonably determine dynamic threshold valve system for the towns' key evaluation indexes; (3) towns should set up a statistics section and statistics department in Northern New Zone, which is responsible for the collation of statistical data and timely feedback; (4) to further clarify and streamline management structure between development and construction offices in towns and the Northern New Zone; (5) coordinate mechanism of distributing benefits from intensive utilization of land between towns and professional Zones of Haidian District; (6) in further studies, increase time-orderly data of the index system, change the static evaluation into dynamic evaluation, so as to offer reference for a new round of planning.

Due to some indexes like eco-friendly are not calculated with township as a unit, or parts of the township are still without a corresponding statistical agency, the eco-environment index and other related data are more difficult to acquire. Therefore, the index system of actual conducted evaluation still needs further complement and improvement. In future, we will recollect the data and conduct more sustained in-depth research so as to promote intensive utilization of land and transformation of growth modes in the towns of Northern New Zone.

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