

Empirical Research on Coordination Evaluation Method of Urbanization, Informatization and Greenization

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Keywords: greenization, coupling coordination degree, sustainable development, smart city, smart-green city

Abstract. This paper directed the limitation of the research on the coordination among urbanization, informatization and greenization, contructed a coordination evaluation method of urbanization, informatization and greenization based on the coupling theory in physics; and gave an empirical test and analysis on the support of Chinese provincial regional data for the year 2014. Study results confirms:the urbanization, informatization and greenization comprehensive development indicator of this paper contructed can accurately reflect the comprehensive development of China's urbanization, informatization and greenization;and the coordination evaluation method of urbanization, informatization and greenization of this paper contructed is a scientific and comprehensive evaluation method of coincidencing the idea of sustainable development. The method has considerable significance theoretical innovation and practical application, can evaluate and analyz availably the coordination among urbanization, informatization and greenization, provide decision references and theory supports for a nation or a region to construct smart city and green city, realize sustainable development.

1 Introduction

Urbanization is a necessary stage for all countries around the world to realize the process of modernization. The rapid development of informatization has greatly promoted the process of urbanization.In the process of urbanization, a series of ecological environmental problems have been produced.How to promote the coordinated development of urbanization, informatization and greenization, is the problem that all countries need to face.Therefore,it has a significant theoretical and practical significance to research theory and practice of the coordination of urbanization, informatization and greenization,for human society to create smart city and green city,and to realize sustainable development finally.Based on the above considerations,this paper contructed an coordination evaluation method of urbanization, informatization and greenization based on the coupling theory in physics;and gave an empirical test and analysis on the support of Chinese provincial regional data for the year 2014.

2 The related research review

2.1 The literature review of related problems

Lin and Liu^[1] studied influence factors of carbon emission during the urbanization of China, and gave the suggestion of reducing carbon emissions.Song and Liu^[2]explored Spatio-temporal analysis of Chinese informatization. At present, the concept of green growth with the highest citation rate is given by OECD^[3].Hu and Zhou^[4]researched the definition and mechanism of green development. Bauhardt^[5] considered the sustainable development of human society depends on the ecologicalization and greenization transformation of the industry.Mathews and Reinert^[6] researched the role of renewable energy,clean technology and resource recycling systems on the green economy. McKendry and Janos^[7]discussed green growth and sustainable development of industrial

cities in developed countries. Liu etc.^[8] studied the evolution characteristics of greenization in China, and other literatures, etc.

2.2 Limitations of existing research

(1) The research on the urbanization and informatization needs to be further deepened at home and abroad.

(2) The research on the greenization is at the initial stage, and the research is not deep enough, and the research has not formed theoretical system.

(3) The coordination and interaction research of urbanization, informatization and greenization is less, and it is difficult to guide the practice.

3 Coordination evaluation method of urbanization, informatization and greenization

3.1 Coordination evaluation indicators system of urbanization, informatization and greenization

This paper contructed a coordination evaluation indicators of urbanization, informatization and greenization, table 1 is the evaluation indicators system. In this paper, we use the factor analysis method to synthesize 4 indicators (Proportion of urban population etc.) into urbanization comprehensive index. Similarly, we use factor analysis method to synthesize 4 indicators (Index of post and telecommunications service etc.) into informatization comprehensive index. And we use factor analysis method to synthesize 4 indicators (Renewable energy power generation ratio etc.) into greenization comprehensive index.

Table 1 Coordination evaluation indicators system of urbanization, informatization and greenization

	Urbanization, informatization and greenization	Evaluation indicator	Concrete representation
Coordination degree of urbanization, informatization and greenization	Urbanization comprehensive index	Proportion of urban population	Urban population /total population (ratio)
		Urban employment population accounts for the proportion of total employed population	The number of urban employed population/total employed population (ratio)
		Proportion of non-agricultural industry	Second and third industry added value/GDP(ratio)
		Engel coefficient of urban residents	Residents food expenditure gross/total personal consumption expenditure (ratio)
	Informatization comprehensive index	Index of post and telecommunications service	Number of Posts and telecommunications business volume/post and telecommunications industry practitioners (yuan/person)
		Computer ownership rate	Computer ownership rate per hundred persons (tai/hundred persons)
		Telephone penetration rate	Telephone penetration rate per hundred persons(tai/hundred persons)
		Internet penetration rate	Internet penetration rate per hundred persons(Percentage)
	Greenization comprehensive index	Renewable energy power generation ratio	Renewable energy power generation accounts for the proportion of total energy power generation (percentage)
		Per capita sulfur dioxide emissions	Annual average sulfur dioxide emissions per capita(ton/person)
		Investment proportion of environmental pollution government	Environmental pollution government investment accounted for GDP (percentage)
		GDP energy intensity	Ten thousand yuan GDP energy consumption(tons of standard coal)

3.2 Coupling degree model and coupling coordination degree model

In this paper, the coupling theory of physics subject is introduced, which is used to explore the coordination degree evaluation of urbanization, informatization and greenization. The model of coupling theory used in this paper is as follows.

1. Coupling degree model

Coupling degree model of physics subject is as follows:

$$C_n = \left\{ \frac{(U_1 \times U_2 \times \dots \times U_n)}{\prod(U_i+U_j)} \right\}^{\frac{1}{n}} \quad (1)$$

In the above formula, U_1, U_2, \dots, U_n represent n systems, C_n represent Coupling degrees of the n systems.

There are three systems(urbanization, informatization and greenization) in this paper, So, the coupling degree of the three systems is as follows:

$$C = C_3 = \left\{ \frac{(U_1 \times U_2 \times U_3)}{(U_1 + U_2 + U_3)^3} \right\}^{\frac{1}{3}} \quad (2)$$

In the above formula, U_1 represent urbanization comprehensive index, and U_2 represent informatization comprehensive index, and U_3 represent greenization comprehensive index. C_3 represent coupling degree index C of the three systems, $0 \leq C < 1$.

2.Coupling coordination degree model

Coupling degree index C express three system coupling degree, but it can't reflect the actual coordination degree of the three systems. Therefore, we need to introduce coupling coordination index D to measure the degree of coordination among the three systems.

$$D = \sqrt{C \times T} \quad (3)$$

$$T = \alpha u_1 + \beta u_2 + \gamma u_3 \quad (4)$$

Among them, D represent coupling coordination index, expresses the degree of coordination and interaction of the systems. T represent comprehensive evaluation index of three systems, reflect the overall efficiency of the three systems. α, β and γ represent undetermined coefficients. Generally speaking, we think that urbanization, informatization and greenization are equally important. So, α, β and γ values are the same, both are $\frac{1}{3}$.

3.3 Coordination degree evaluation standard of Urbanization,Informatization and Greenization

Coupling coordination index D is the indicator which measures the degree of coordination among Urbanization, Informatization and Greenization, the measuring standard is in Table 2.

Table 2 Coordination degree evaluation standard of urbanization,informatization and greenization

Coordination development phase	Coupling coordination degree of D value	Coordination type	Coordination development phase	Coupling coordination degree of D value	Coordination type
Low level coordination: Very little contact	0.0000-0.0999	Extreme lack of coordination	Strengthen coordination: Running in contact	0.5000-0.5999	Reluctant coordination
	0.1000-0.1999	Serious lack of coordination		0.6000-0.6999	Primary coordination
	0.2000-0.2999	Moderate lack of coordination		0.7000-0.7999	Intermediate coordination
Start coordination: Contend with each other	0.3000-0.3999	Slight lack of coordination	High level coordination: Fusion and symbiosis	0.8000-0.8999	Good coordination
	0.4000-0.4999	On the verge of lack of coordination		0.9000-1.0000	High quality coordination

4 Evaluation and analysis of the coordination degree of China's urbanization,informatization and greenization

Specific data of each indicator which is showed in table 1, of coordination evaluation among China's urbanization,informatization and greenization in 2014, is derived from *China Statistical Yearbook(2015)*, Statistical Yearbook of Chinese various provincial regions in the year 2015, *China economic information network statistics database*, CNKI“Statistical database of China's economic and social development”, People's Republic of China“national statistical database” and other relevant statistical data. According to the coordination evaluation method of urbanization,

informatization and greenization presented above, we got coordination degree evaluation results of China's urbanization, informatization and greenization in 2014, the results are shown in table 3.

Table 3 Coordination degree evaluation results of urbanization, informatization and greenization of Chinese provincial regions in 2014

Geographical district	Provincial region	Coupling degree index C	Comprehensive evaluation index T	Coupling coordination index D	Coordination degree evaluation
North China	Beijing	0.3333	0.7952	0.5148	Reluctant coordination
	Tianjin	0.3331	0.7864	0.5118	Reluctant coordination
	Hebei	0.3286	0.5791	0.4362	On the verge of lack of coordination
	Shanxi	0.3264	0.3875	0.3556	Slight lack of coordination
	Inner Mongolia	0.3295	0.4083	0.3668	Slight lack of coordination
Northeast China	Heilongjiang	0.3289	0.5642	0.4308	On the verge of lack of coordination
	Jilin	0.3306	0.6146	0.4508	On the verge of lack of coordination
	Liaoning	0.3314	0.6459	0.4627	On the verge of lack of coordination
East China	Shanghai	0.3332	0.7931	0.5141	Reluctant coordination
	Jiangsu	0.3328	0.7124	0.4869	On the verge of lack of coordination
	Zhejiang	0.3325	0.7092	0.4856	On the verge of lack of coordination
	Anhui	0.3272	0.4370	0.3781	Slight lack of coordination
	Fujian	0.3321	0.6732	0.4728	On the verge of lack of coordination
	Shandong	0.3317	0.6628	0.4689	On the verge of lack of coordination
	Jiangxi	0.3296	0.4537	0.3867	Slight lack of coordination
Central China	Henan	0.3280	0.5094	0.4088	On the verge of lack of coordination
	Hubei	0.3298	0.5892	0.4408	On the verge of lack of coordination
	Hunan	0.3283	0.5427	0.4221	On the verge of lack of coordination
South China	Guangdong	0.3329	0.7326	0.4938	On the verge of lack of coordination
	Guangxi	0.3276	0.4271	0.3741	Slight lack of coordination
	Hainan	0.3291	0.5240	0.4153	On the verge of lack of coordination
Southwest China	Chongqing	0.3302	0.6231	0.4536	On the verge of lack of coordination
	Sichuan	0.3265	0.4795	0.3957	Slight lack of coordination
	Guizhou	0.3226	0.3428	0.3325	Slight lack of coordination
	Yunnan	0.3230	0.3693	0.3454	Slight lack of coordination
	Tibet	0.3217	0.3182	0.3199	Slight lack of coordination
Northwest China	Shaanxi	0.3309	0.5947	0.4436	On the verge of lack of coordination
	Gansu	0.3205	0.2956	0.3078	Slight lack of coordination
	Qinghai	0.3239	0.3285	0.3262	Slight lack of coordination
	Ningxia	0.3247	0.3076	0.3160	Slight lack of coordination
	Xinjiang	0.3258	0.3519	0.3386	Slight lack of coordination

The data in table 3 are analysed as follows. In the coordination degree of China's provincial regional urbanization, informatization and greenization in 2014, Beijing, Shanghai, Tianjin belong to the reluctant coordination. Guangdong, Jiangsu, Zhejiang, Fujian, Shandong, Liaoning, Chongqing, Jilin, Shaanxi, Hubei, Heilongjiang, Hebei, Hunan, Hainan, Henan belong to On the verge of lack of coordination. Sichuan, Jiangxi, Anhui, Guangxi, Inner Mongolia, Shanxi, Yunnan, Xinjiang, Guizhou, Qinghai, Tibet, Ningxia, Gansu belong to Slight lack of coordination. Overall, there are On the verge of lack of coordination and Slight lack of coordination in China's provincial regional urbanization, informatization and greenization in 2014, except Beijing, Shanghai, Tianjin which belong to the reluctant coordination. The coordination level of urbanization, informatization and greenization is determined by the comprehensive factors, generally speaking, the developed region of economy, science and technology, social development, urbanization degree, informatization degree, Green economy, the coordination among urbanization, informatization and greenization is relatively high. At present, the urbanization, informatization and greenization strategy which is implemented in China's national level, is an opportunity for the China's provincial region. Every province should hold this opportunity, to promote vigorously the local area of urbanization, informatization and greenization, to develop vigorously smart city and green city, and to promote the coordination between them, that is smart-green city. This is a necessary way which is used to narrow the regional gap, to make China as a whole realize modernization, and to achieve sustainable development.

5 Conclusions

This paper directed the limitation of the research on the coordination among urbanization, informatization and greenization, contructed a coordination evaluation method of urbanization, informatization and greenization based on the coupling theory in physics; and gave an empirical test and analysis on the support of Chinese provincial regional data for the year 2014. Study results confirms:the urbanization,informatization and greenization comprehensive development indicator of this paper contructed can accurately reflect the comprehensive development of China's urbanization,informatization and greenization;and the coordination evaluation method of urbanization,informatization and greenization of this paper contructed is a scientific and comprehensive evaluation method of coincidencing the idea of sustainable development.The method has considerable significance theoretical innovation and practical application,can evaluate and analyz availably the coordination among urbanization,informatization and greenization,provide decision references and theory supports for a nation or a region to construct smart city and green city, realize sustainable development.

6 Acknowledgements

This study is supported by The National Natural Science Foundation Major International (Regional) Joint Program of China (No.71320107006); The National Social Science Foundation Key Projects of China (No.14AZD090).

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