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Evaluation research on the coordinated development of regional social economy and oasis ecosystem in northwestern cities and towns

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ABSTRACT

It is a main task of regional development to realize a coordinated development of regional social economy and the oasis ecosystem. This paper took 14 cities in northwest of China as an example and made a deep analysis on their development status, established a comprehensive evaluation index system of social economy and the oasis ecosystem. Using the entropy weight method, coordination development model and economic and ecological benefits criterion, a quantitative analysis was carried out to study the coordinated development degree of regional social economy and the oasis ecosystem. The results showed that: (1) The overall level of coordinated development degree between economy and ecological systems of the 14 cities is not high, with the average degree of coordinated development of 0.46. (2) Overall level of social economic and ecological environment benefit is low with average economic benefit of 0.21 and average ecological benefit of 0.30. (3) There are four cities which belong to the economy and environment synchronous development type, two belong to economic oriented type and the others are environment oriented type.

KEYWORDS

The northwest; Social economy and the oasis ecosystem; Coordinated development; Evaluation.

INTRODUCTION

Sustainable development is the task and ultimate goal of national and regional coordinated development. While meeting the social and economic development, we must take environmental requirements into account as well. Social economy system and ecological system are open and complex systems. Especially in the arid areas with poor natural conditions, oasis as the carrier of social economy and ecological system provides the basic water and soil resources and biological resources for human production and living. Therefore, we need to coordinate the relationship between the two. Many scholars have conducted a certain exploration on the study of coordinated development of regional social economic system and ecosystem with both qualitative methods and quantitative methods. In recent years, the researches are more of quantitative methods which are mainly index system assessment, ecological footprint evaluation, energy analysis, material flow analysis and ecosystem service value accounting, etc. The fragility of ecological system in northwest town areas is becoming more and more serious. As a result, a comprehensive evaluation of the coordination degree of social economy and ecological system and its benefits is particularly important to cities in arid areas. In this paper, we selected 14 cities in the north west of China as the research area and carried out a comprehensive evaluation on the coordination and ecological economic benefits of social and economic system and ecological system, in order to scientifically analyze the development status of the two systems of northwest cities and provide the scientific basis and theoretical support for the sustainable development of the entire region[1].

MATERIALS AND METHODS

General situation in the study area

Study area

On the definition of northwestern town areas, different scholars have different understanding. This paper selected Mulei, Usu and Karamay urban agglomeration as the study area. Till year 2011, 14 cities in this region are respectively Urumqi Municipality, Karamay City, Shihezi Cty, Kuytun City, Changji City, Fukang City, Wujiaqu City, WuSu County, Shawan County, Manas County, Hutubi County, Mulei County, Qitai County and Jimsar County. The space distribution between the 14 towns and cities is concentrated. Oasis is with integrity and certain economic influence. The urban agglomeration zone centered on Urumchi plays a key role in the stability and coordinated development of the social economy and the oasis ecosystem[2, 3].

Development status of the socioeconomic system of research area

Based on the rapid growth of western region economy in 2010, the rapid growth continued in 2011. The gross regional domestic product reached 9.973826 trillion yuan, an increase of 14.03% over the previous year based on comparable price calculation. Though the growth rate falls by 0.19% over the previous year, it is 3.42% higher than the east and 1.25% higher than the central region and 2.25% higher than the whole nation. It accounts for 19.24% of the proportion of GDP, increased by 0.56% compared with 2010. And it contributed to the national regional economic coordinated development[4].

The economic contribution rate of the 14 cities selected in this paper occupies a decisive position compared to other regions. It located right in the heart of economic development. Especially in Karamay where there are rich mineral resources, the social economy developed fast and people's living standards improved significantly.

Development status of oasis ecosystem of research area

There are little water and much soil in the northwest region while the southwest region is with much water and little soil. The northwest region accounts for 44.5% of the national territorial area. However, due to the drought, the annual average water resources quantity is only 234.4 billion cubic meters, which is only 8% of the total water resources of the country and the availability is less than 120 billion cubic meters. Moreover, the spatial distribution of water resources is uneven. Xinjiang and Qinghai provinces account for 68% of total water resources of the northwest. In terms of Xinjiang province, its northwest area accounts for 50% of the national territorial area while its water quantity accounts for 93% of the region. The southeast region accounts for 50% of the national territorial area while its water resources accounted for only 7%. There is abundant rainfall in southwest China, average annual volume of water resources is 1.2752 trillion cubic meters and available water quantity is of 347 billion cubic meters. But the water resources distribution mismatches concentration water area in southwest area. Basin and level ground area with relatively developed economy and concentrated cultivated land is with less amount of precipitation and is facing the problem of water shortage[5].

Oasis is the foundation of human survival and development in arid areas. The stability of oasis ecosystem has a direct impact on human economic and social development and the spread and continuation of civilization. The oasis system in town area is divided into two categories, natural oasis and artificial oases. In recent years, the area of natural oasis is reducing year by year while the artificial oasis is increasing. The northwest region is the natural ecological fragile area in our country because of its special geographical location. The contradiction of relation between people and land is obvious and the area is faced with a series of ecological problems such as desertification, soil salinization and water and soil loss. Ecological environment problems caused by mining of mineral resources are increasingly serious. With the water resources reducing year by year, a variety of ecological problems appear and influence each other which restricted the economic development of the whole area[6].

Data source

The data in this paper is from China Statistical Yearbook of 2011, statistical yearbook of the northwest 14 towns and leading cadres' manual of 2011, water resources bulletin of 2010, land use bulletin and environment bulletin. Part of the data comes from public offering literature and results of field investigation.

Research method

Construction of index system

A scientific index system can correctly reflect the coordinated development level of the social economy and the ecosystem of a region[8]. Northwestern town area based on its special geographical position and administrative divisions, scientific, integrity, hierarchy and dynamic, acquired and operability principle and the comprehensive evaluation index system of ecological economy put forward by domestic scholars, we select 13 factors to construct the composite index system, as shown in TABLE 1. There are two layers reflecting the ecological system which are ecological basis (water resources, oasis area, arable land, grassland area) and ecological pressure (population density, air quality), and the factors reflecting the social and economic development are the social economy (per capita GDP, the entire social investment in fixed assets, the total retail sales of social consumer goods) and national lives (average wages of staff and workers, urban disposable income, the income of the peasants and herdsmen per capita, and doctor number per ten thousand people)[9, 10].

TABLE 1: The composite index system and index weight of coordinated development of social economy and the oasis ecosystem in northwestern cities and towns

Item	First indicator	Weighted value	Secondary indicator	Weighted value
Ecological environmental indicator (0.5394)	Ecological basis(AI)	0.2636	Water resources quantity (A11)	0.0502
			Oasis area(A12)	0.0747
			Cultivated area 9A13)	0.0805
			Grassland area9A14)	0.0581
	Ecological stress (A2)	0.2758	Population density(A21)	0.1419
			Air quality(A22)	0.1339
Social and economic development indicator (0.4606)	Social economy(BI)	0.0968	Per capita GDP(B11)	0.0444
			Total fixed asset investment (B12)	0.0340
			Total retail sales of consumer goods in the whole society(B13)	0.0184
	National lives (B2)	0.3638	Average wages of staff and workers(B21)	0.1113
			Urban per capita disposable income(B22)	0.0735
			Income of the peasants and herdsmen per capita(B23)	0.1163
			Doctor number per ten thousand people(B24)	0.0627

Standardization of data values

Since the constructed index system is a comprehensive evaluation index system, we must carry out standardized treatment to eliminate the effect of dimension on the results. This paper applies linear difference method for standardization processing of raw data. Assume there are total n indexes in the system. The matrix is $X = \{x_{ij}\}_{s*n}$, s is the number of towns. The standardized approach of positive indicators is $Y = \frac{X - X_{\min}}{X_{\max} - X_{\min}}$, and the standardized approach of negative indicators is $Y = \frac{X_{\max} - X}{X_{\max} - X_{\min}}$. After standardization, the data matrix is $Y = \{y_{ij}\} x * n$.

Index weight

In the comprehensive evaluation index system, influence degree of each index to the evaluation results is not the same, which requires the weight to be given to show the strength of the various indicators. The methods of empowerment of weight mainly include the Delphi Technique, Analytic hierarchy process (AHP), principal component analysis, factor analysis, entropy weight method. This paper applies the entropy weight method to calculate the weight of each index.

Suppose there are n indicators, the information entropy of type j indicator is drawn by the following equation:

$$e_j = -k\sum_{i=1}^{m} y_{ij} \ln y_{ij} \quad (1)$$

In the equation, $k > 0, k = 1/\ln m, 0 \le e_j \le 1, m$ is the number of towns. To avoid the situation of $\ln^0$, substitute the 0 value with the value of 0.00001, then the weight of type j indicator is as follows:

$$w_j = \frac{1 - e_j}{\sum_{j=1}^{n} (1 - e_j)} \quad \textbf{(2)}$$

In the above equation, n is the number of indicators.

Mathematical model

For the coordinated development of oasis ecosystem and economy, we should pay attention to both social economic benefits and ecological benefits of social and economic system and oasis ecosystem. Construct the oasis ecological benefit function and economic benefit function[7].

Ecological benefit function: $$f(x) = \sum_{i=1}^{m} w_i x_i \quad \textbf{(3)}$$

Economic benefit function: $$g(y) = \sum_{j=1}^{m} w_j y_j \quad \textbf{(4)}$$

In the equation, i and j respectively describes the indicator number of ecology and economy. w_i and w_j are respectively the weight of each indicator. x_i and y_j are the indicator values of the ecological and economic system after standardization.

In mathematics, the deviation between functions can be used to measure size of the coordination degree. The greater the deviation, the lower the coordination degree. To realize the coordinated development of ecology and economy of oasis, the deviation coefficient C_v is the smaller the better. That is, the bigger the better of C_v'.

$$C_v = \frac{2s}{f(x)+g(y)} = 2\left(\sqrt{1-\frac{f(x)g(y)}{\left(\frac{f(x)+g(y)}{2}\right)^2}}\right) \quad \textbf{(5)}$$

$$C_v' = \frac{f(x)g(y)}{\left(\frac{f(x)+g(y)}{2}\right)^2} \quad \textbf{(6)}$$

Based on the above equation, we can construct the regional ecological and economic coordination degree calculation formula as follows:

$$C = \left(f(x) g(y) \left(\frac{f(x) g(y)}{2} \right)^{-2} \right)^{k} \quad \textbf{(7)}$$

In the equation, c is the coordinated development coefficient; k is the accommodation coefficient, ($k \geq 2$). Here, we select k=2.

Then, we introduce the coordination degree development model:

$$D = \sqrt{C^{*} T} \quad \textbf{(8)}$$

In the equation, C is the coordination degree, T is the overall benefit of social economy and the oasis ecosystem of all the towns, then, T can be drawn as follows:

$$T = af(x) + bg(y) \quad \textbf{(9)}$$

In the equation, a and b are the weights of the two systems.

Put the normalized value of the 14 cities of the northwest area to the above equations, then, the ecological benefits and economic benefits, coordination degree and coordination development degree and eco economic comprehensive benefit can be obtained, as shown in TABLE 2.

TABLE 2: Calculation results of regional social economy and oasis ecological coordination development level in northwestern cities and towns

Cities and towns	Ecological benefit $f(x)$	Economic benefit $g(y)$	$g(y)/f(x)$	Coordination degree C	Coordinated development degree D	Ecological economic benefit T
Urumqi	0.1213	0.2620	2.1590	0.7489	0.4733	0.1861
Karamay	0.3003	0.3860	1.2851	0.9691	0.5738	0.3398
Shihezi	0.2111	0.2186	1.0358	0.9994	0.4631	0.2146
Kuytun	0.1697	0.1750	1.0313	0.9995	0.4148	0.1721
Usu	0.4155	0.1626	0.3913	0.6538	0.4421	0.2990
Shawan	0.4807	0.1338	0.2784	0.4643	0.3860	0.3210
Changji	0.2760	0.2458	0.8907	0.9933	0.5102	0.2621
Fukang	0.2476	0.2257	0.9115	0.9957	0.4863	0.2375
Hutubi	0.3319	0.1825	0.5498	0.8384	0.4649	0.2631
Manas	0.3615	0.2119	0.5862	0.8685	0.5041	0.2926
Qitai	0.3577	0.2046	0.5771	0.8613	0.4981	0.2880
Jimsar	0.3353	0.1759	0.5247	0.8151	0.4620	0.2619
Mulei	0.3396	0.1353	0.3985	0.6642	0.4038	0.2455
Wujiaqu	0.2608	0.1838	0.7048	0.9409	0.4605	0.2254

Through the analysis of the above formulas, it can be seen that the value of $g(y)/f(x)$ is used to show which system is in the leading position. By uniform distribution function method, coordination degree level and ecological and economic development division standard can be obtained, as shown in TABLE 3 and TABLE 4.

TABLE 3 : Standard of division of coordinated development degree

0<D≤0.125	0.125<D≤0.25	0.25<D≤0.375	0.375<D≤0.5	0.5<D≤0.625	0.625<D≤0.75	0.75<D≤0.875	0.875<D≤1.000
Extreme imbalance	Serious imbalance	Moderate imbalance	On the verge of imbalance	Barely coordination	Moderate coordination	Good coordination	Excellent coordination

TABLE 4 : Standard of division of ecological and economic development order

g(y)/f(x)>1.2	1.2≤g(y)/f(x)≤0.8	g(y)/f(x)<0.8
Economic leading type	Synchronous development type	Environmental leading type

TABLE 5 : Social economy and the oasis ecosystem development type and order in northwestern cities and towns

Cities and towns	Development type	Ecological and economic development order	Rank of ecological economic benefit (T)
Urumqi	On the verge of imbalance	Economic leading type	13
Karamay	Barely coordination	Economic leading type	1
Shihezi	On the verge of imbalance	Synchronous development type	12
Kuytun	On the verge of imbalance	Synchronous development type	14
Usu	On the verge of imbalance	Environmental leading type	3
Shawan	On the verge of imbalance	Environmental leading type	2
Changji	Barely coordination	Synchronous development type	7
Fukang	On the verge of imbalance	Synchronous development type	10
Hutubi	On the verge of imbalance	Environmental leading type	6
Manas	Barely coordination	Environmental leading type	4
Qitai	On the verge of imbalance	Environmental leading type	5
Jimsar	On the verge of imbalance	Environmental leading type	8
Mulei	On the verge of imbalance	Environmental leading type	9
Wujiaqu	On the verge of imbalance	Environmental leading type	11

RESULT AND ANALYSIS

(1) We can see from TABLE 2, in terms of coordinated development degree of economy and ecology system among all the 14 cities, Karamay is the highest with the value of 0.57. The lowest is Shawan County with the value of 0.39. The coordinated development degree value is distributed in numerical interval of 0.4 to 0.5. Only the value of Karamay and Changji is greater than 0.5. According to the coordination degree hierarchy standard, Karamay and Changji belong to the barely coordination type and the other cities are on the verge of coordination. Economic development of Karamay mainly depends on the oil and gas and mineral resources. It has good economic foundation, at the same time pays attention to ecological protection with large investment. Changji in recent years is with rapid economic development and sticks to the path of sustainable development of economy and ecology, so its coordination degree ranked top of the 14 cities.

(2) Among all the 14 cities, the largest economic benefit is in karamay and the smallest is in Mulei County. Shawan County is with the highest ecological benefits and Urumqi Municipality is with the lowest ecological benefits. As can be seen from the list, the region dominated by agriculture industry with abundant water and soil resources such as Usu City, Shawan County, Manas County, Qitai County and Hutubi County all ranked in the forefront. This is mainly because of the differences of regional environment, resources endowment and economic development pattern of different cities. In the rank of general ecological and economic benefits of all cities, Karamay ranked first and the last one is Shihezi City. There are two reasons for this. First, in the social economy and the oasis ecosystem index, weight value of indicators of oasis ecological aspects is greater than the weight value of social and economic development. Second, though the index of ecological aspects of Karamay City is not high, due to its strong economic base, its social and economic indexes are far higher than other towns.

(3) Among all of the cities in the northwest region, there are four cities which belong to economic environment synchronous development type, which are Shihezi, Kuytun, Changji and Fukang. There are two cities which belong to the economic leading type which are Urumqi and Karamay. The rest of the towns belong to the envionmetnal leading type. Since Karamay has been given priority to industrial development for a long time, its ecological environment is fragile. Urumqi is a comprehensive industry development type with rapid economic development. People's living standard is generally higher than elsewhere in the region. However, due to its rapid economic development and urbanization rate, it inevitably caused environmental profit and loss. The four cities which belong to the economic environment synchronous development type are with basically the same percentage of workers and peasants and their development speed is consistent. Most of the rest of the towns take agriculture as the leading industry with relatively slow industrial development, which is related to its long-term development mode and economic policy.

DISCUSSION

The northwest town area as one of the typical representatives of urban agglomeration in arid region, its social and economic system and the oasis ecosystem has uniqueness. In recent years, due to the advancement of western development policy, regional social economic development level is under rapid increase and the urbanization level improved significantly. But the rapid development of economy threatens to oasis ecological environment and security to some extent. The development of towns and oasis is a process of dynamic change. The influence of natural conditions and macro policy can cause a series of environmental and economic problems[11, 12].

The process of social economy and the oasis ecosystem coupling is a process of interaction of common development. For the mode judgment, it should not only reflect the development level of both, but also reflect the synergy degree between the two. Only when both the systems have the high level of development can the highest degree of coupling be realized, and thus the coordinated development degree can be increased. Besides, coordinated development level of economy and ecology system of all 14 cities is at low level. This is mainly caused by different economic and ecological benefits of the two systems. And the results accord with the actual situation.

To speed up the regional development of social economy and ecological system of the northwest towns, we should strengthen the position of agriculture as the foundation of the economy, increase capital input to the farming and animal husbandry. The northwest region’s water and soil resources are consumed mainly by farming and animal husbandry and excessive unreasonable soil and water resources development is the main cause of ecological environment deterioration. In order to change this situation, we should transform the traditional agriculture of low input, low output, high resource consumption into modern agriculture with high input, high output, low resource consumption, to fundamentally solve the problem and strengthen the basis construction of farming and animal husbandry[13].

Moreover, ecological environment construction department coordination mechanism in the northwest region should be established. Northwest area’s ecological environment construction requires a

comprehensive consideration of related department work, especially in agriculture, forestry, water, and urban construction, environmental protection, poverty alleviation etc. To unify planning, work together to make the state and society input play the biggest benefit. The ecological environment construction department coordination mechanism of northwest area should be further improved. The relevant provinces and autonomous regions need also to establish and perfect the corresponding coordination mechanisms.

At the same time, we should develop industrial and mineral industry; carry out the process of urbanization. By raising the level of social productive forces, improve the utilization efficiency and benefits of water and land resources so as to realize the human and the nature harmonious coexistence. In the development of industrial and mineral industry, we must prevent the low level of redundant construction. In the development of urbanization, separating from local conditions should be avoided as well as blind comparison of urbanization rate.

Finally, speed up the development of economy, determined to prevent and control pollution. Prevention and control of pollution is one of the important conditions for the sustainable development of northwest area. Leaders at all levels must actually raise awareness and formulate correct development plan. Strengthen the management of new project; put an end to the protection of pollution project. Increase capital investment of pollution prevention and control and strictly enforce environmental protection laws and regulations. For the water environment that has been contaminated, firmly governance should be carried out in a timely manner, so as not to pay a higher price in the future[14].

CONCLUSION

(1) Through calculating, it is found that the ecological benefits and economic benefits present an opposite trend. The higher the economic benefits, the lower the ecological benefits. The coordination degree of the whole area was high, but the coordinated development degree is not very ideal. Integrated ecological economic benefits are generally at the low level. Most cities are on the verge of disorder. The city with best economic development also only achieved barely coordination standard[15].

(2) Overall level of economic and ecological system coordinated development degree is not high and there is little difference between regions. The average coordinated development degree of the whole area is only 0.46, which is on the verge of disorder.

(3) The overall level of economic society and ecological environment development is low. Economic benefit average value is only 0.21. It is lower than the average of the national economy level of development at the same period. The differences between different cities and towns are large.

(4) Among all the 14 cities and towns, there are two belonging to the economic environment synchronous development type; two belonging to the economic leading type and the rest are the environmental leading type.

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