
The Coordinated Development About Eco-environment and Economy: A Case Study of Guanzhong Area

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Abstract

With high pollution, high emissions of extensive economy development mode, resources and environment are facing the serious situation of deteriorating, which don't make human allow to ignore the contradictions eco-environment and economic development. This study aim to the research of coupling relationship between eco-environment and economic development in Guanzhong area, by establishing evaluation of index system between eco-environment system and economic system, using principal component analysis and mathematical model method. The results show that the relations mainly manifested three characteristics of coupling coordination from the time sequence. First, the coupling coordination degree of evolution kept rising trend in fluctuation. Second, the study area had obvious characteristics in every-stage, which show developing slowly, fast developing of falling speed and rapidly rising speed of development. Third, the coupling of systems as a whole and all parts showed a trend of "V" type in the direction of coordinated development. The space angle mainly had two characteristics: first, there were mainly three types regions in the Guanzhong area. The first kind of coupling development level is high but not stable. The second type of coupling is coordination development and keep stable. The third class coupling level is low and stable development. Second, the differences of regional internal gradually were narrow towards a coordination trend. Therefore, this study puts forward some effective suggestions from the macro-perspective and micro-perspective, which is theoretical basis for the sustainable development path.

Keywords: eco-environment, economic development, coupling coordinate, Guanzhong

Wang X, Cao L, Shen L, Bai Q (2018) The Coordinated Development About Eco-environment and Economy: A Case Study of Guanzhong Area. Ekoloji 27(106): 555-562.

INTRODUCTION

During the period of rapid economic development, mankind is facing a grim situation in which the ecological environment is deteriorating. Especially since China entered the new normal of the economy, environmental problems have clearly affected human life. For example, the appearance of smog has seriously affected people's daily travel, water pollution and soil pollution have caused great hidden dangers to human diet. Therefore, how to adjust the balance between the ecological environment system and the economic system and how to solve the contradiction between the two systems become the keys to the sustainable development of the regional eco-economic system. A lot of researches have been done on how the two systems interact and their mechanisms at home and abroad (Dinda 2004, Ding 2010, Dong 2010a, 2010b, Li 2012b, Stern 2001, Tang 2014). And the research methods are not the same, such as system dynamics method, grey relational analysis method, coupled system mathematical model, energy value theory and 3S

technology quantitative analysis (Li 2012a, Shi 2012, Wang 2013, Wu 1996). Looking at the research results of predecessors, domestic research on Guanzhong area mainly focuses on the evolution of ancient ecological environment and social economic structure (Zheng 2001), and ecological security in Guanzhong area (Meng 2014, Xue 2011) and the development of Guanzhong City Group (Ren 2007, Xue 2013). In addition, the study on the coupling of ecological environment and economic development in Guanzhong area is mainly studied from the micro aspect, such as the coupling mechanism of a certain factor in the ecological environment and economic development, mainly in terms of land resources and water resources (Wang 2015, Zhuo 2010). Therefore, from the macroscopic point of view, this paper uses the principal component analysis method to calculate the index weights, and uses the coupling coordination degree model to study the coupling relationship and the space-time characteristics of the two major systems in Guanzhong area. In view of the evolution trend of

Table 1. Indicator system of the study area

	Ecosystem indicator		Economic system indicator
Natural resources	x1Common cultivated land area at the end of the year (thousand hectares)	Economic strength	y1GDP per capita (yuan)
	x2Per capita daily water consumption (liter)		y2Total fixed assets investment (100 million yuan)
	x3Average temperature (degrees Celsius)		y3Local general budget revenue (100 million yuan)
	x4Precipitation (mm)		y4Financial expenditure (100 million yuan)
	x5Landscaping coverage (hectare)		y5Total import and export (100 million US dollars)
Environmental pollution	x6Industrial wastewater discharge (10,000 tons)	Industrial structure	y6Primary industry (100 million yuan)
	x7Industrial exhaust emissions (100 million cubic meters)		y7Second industry (100 million yuan)
	x8Industrial solid waste production (10,000 tons)		y8Tertiary industry (100 million yuan)
Environmental prevention	x9Three waste comprehensive utilization product output value (ten thousand yuan)		y9Industry (100 million yuan)
	x10Wastewater treatment facility treatment capacity (10,000 tons)	Resident income	y10Total retail sales of social consumer goods (100 million yuan)
	x11Domestic garbage removal volume (10,000 tons)		y11Per capita net income of farmers (yuan)
			y12Per capita disposable income of urban residents (yuan)

internal factors of the system, this paper puts forward some practical and effective suggestions.

DATA SOURCE AND RESEARCH METHOD

Data Source

The Guanzhong area is located in the Weihe alluvial plain in the northern foot of Qinling Mountains, Shaanxi Province, with an average elevation of about 500m. It starts from Baoji in the west, connects to Shaoguan in the east, connects Qinling in the south, and goes to the northern Shaanxi Plateau in the north. It mainly includes five administrative areas including Xi'an, Tongchuan, Baoji, Xianyang and Weinan. This is a fertile, productive, and densely populated area. Since the founding of New China, Guanzhong has always been a key area for China's productivity distribution. It has been positioned as an important production and research base in Shaanxi and even the Northwest in the national regional economic strategy. Guanzhong has a long history and culture and is one of the birthplaces of the Chinese nation. With its unique superior position, it developed into the ancient Chinese Yellow River Cultural Center from the Qin and Han Dynasties to the Sui and Tang Dynasties. Its human landscape is densely distributed and has a high historical and cultural value. The Guanzhong area occupies an important strategic position in Shaanxi Province. Its development not only plays a role in radiating the surrounding cities, but also plays a key role in the strategic layout of the country's implementation of the western development. Therefore, this study takes the Guanzhong area as the research scope, and the main source of the research data is the Statistical Yearbook of Shaanxi Province from 2000 to 2018 and the statistical yearbook of the relevant cities, the Statistical Communiqué of National Economic and Social Development of each city from 2000 to 2017 and Environmental Statistics Annual Report.

Research Method

Construction of indicator system

Throughout a lot of research results (Wan 2011), Domestic scholars mainly focus on the four dimensions of regional economy, society, environment and ecology to study the evaluation index system. With reference to the sustainable development index system designed by Mao Hanying (Mao 1996), combined with the comprehensive regionalization index system in Northwest China (Liu 2011). According to the regional background, we select representative factors that can objectively reflect the ecological environment and economic development status factors, and follow the principles of science and operability, consult industry experts, and finally establish an evaluation index system. In the ecosystem indicators, 11 indicators are selected from the aspects of natural resources, environmental pollution and environmental management to reflect the level of ecological environment quality; In the economic system, 12 indicators are selected from the aspects of economic strength, industrial structure and household income and consumption to indicate the level of economic and social development in Guanzhong area (Table 1).

Coupling coordination model

The raw data is processed by principal component analysis, and the original data is first quantified. The function model is generally:

$$y(x_{ij}) = \frac{x_{ij}-m_{ij}}{M_{ij}-m_{ij}} \text{ (Positive indicator)}$$

$$y(x_{ij}) = \frac{M_{ij}-x_{ij}}{M_{ij}-m_{ij}} \text{ (Reverse indicator)}$$

In the formula, x_{ij} is the original index, M_{ij} and m_{ij} means the upper limit and lower limit of the index j . The ratio of the feature value corresponding to each principal component to the sum of the total feature values of the extracted principal components is used as the index weight. Calculated as follows:

Table 2. Comprehensive development of the study area

Region	Ecosystem				Economic system			
	2000	2005	2010	2014	2000	2005	2010	2014
Xi'an	0.561	0.658	-0.02	0.689	0.484	0.867	0.89	0.896
Tongchuan	0.613	0.412	0.74	0.418	0.108	0.064	0.122	0.106
Baoji	0.524	0.478	0.708	0.384	0.303	0.438	0.327	0.432
Xianyang	0.485	0.327	0.54	0.392	0.414	0.579	0.344	0.621
Weinan	0.533	0.409	0.829	0.373	0.243	0.382	0.257	0.420
Average	0.543	0.457	0.560	0.451	0.310	0.466	0.388	0.495

$$w_{ij} = \frac{C_{ij}}{\sum_{i=1}^m \sum_{j=1}^n C_{ij}}$$

In the formula, w_{ij} is the evaluation weight of index j of the subsystem I, C_{ij} is the main component contribution of the index j of the system, m represents the number of subsystems, and n is the number of extracted principal components. According to the principal component comprehensive model, comprehensive evaluation of the ecological environment and economic system efficacy is carried out on the premise that all indicators are selected as the main components. Its calculation formula is:

$$Z(x) = \sum_{i=1}^m a_i x_i ; Z(y) = \sum_{j=1}^n b_j y_j$$

In the formula, $Z(x)$ and $Z(y)$ are comprehensive evaluation indexes for the ecological environment system and economic system in Guanzhong area. a_i and b_j means the weight of each element, and x_i and y_j are the standard values. Through the measurement of the relationship between $Z(x)$ and $Z(y)$, the status of matching ecosystems to economic systems can be assessed. Refer to the capacity coefficient model in physics to further promote the coupling model of ecosystem and economic system:

$$C = 2 \sqrt{\frac{Z(x) * Z(y)}{[Z(x) + Z(y)]^2}}$$

where: C is the degree of coupling, the smaller the C value, the less coordinated the system, the larger the C value, the better the state of coordination. Although the coordination degree model can distinguish the degree of coordination between the ecological environment and economic development, it cannot determine the degree of coordination between the two subsystems under what level of comprehensive development. Therefore, in order to more accurately reflect the level and extent of coordinated development of the ecological environment and economy, this study expands the coupling degree model and obtains a coupling coordination degree model:

$$D = \sqrt{C * T}, \text{ where } T = a * Z(x) + b * Z(y)$$

where D is the coupling coordination degree of the composite system; C is the coupling degree of the composite system; T is the comprehensive evaluation index of the ecological environment system and the economic system, and a and b are both 0.5.

DATA ANALYSIS

Comprehensive Evaluation Analysis

This paper selects the data of 2000, 2005, 2010 and 2014 to make a comprehensive evaluation and analysis of the coordinated development of five urban systems in Guanzhong area.

Comprehensive evaluation of ecological environment system

The comprehensive evaluation index of the ecological environment in Guanzhong area is generally at the upper-middle level (**Table 2**), and the average value is between 0.45 and 0.56, and its development trend is declining. The comprehensive evaluation index of the ecological environment in Guanzhong area mainly presents two evolutionary trends: the first category is the “V” type. The comprehensive benefits of Xi’an’s ecological environment are high, the development speed is fast, the fluctuations are large and unstable, and the “V” evolution trend of rising, then decreasing and then rising is presented. The second type is the inverted “V” type. The comprehensive evaluation index of Tongchuan, Baoji, Xianyang and Weinan was relatively stable, and its development trend was the inverted “V” type with the first decline and then the increase.

Comprehensive evaluation of economic system

The overall economic development level in Guanzhong is low, and the comprehensive economic evaluation index is between 0.31 and 0.49. Its development trend is rising in volatility, and the regional internal development gap is large (**Fig. 1**). Xi’an has the highest comprehensive economic benefits and keeps rising. Before 2005, the development speed was very fast. After 2005, the development speed was slow; Tongchuan’s economic comprehensive benefit level was the lowest, showing slight fluctuations; the economic benefits of Xianyang, Baoji and Weinan showed a wave trend, with a peak in 2005 and a low peak

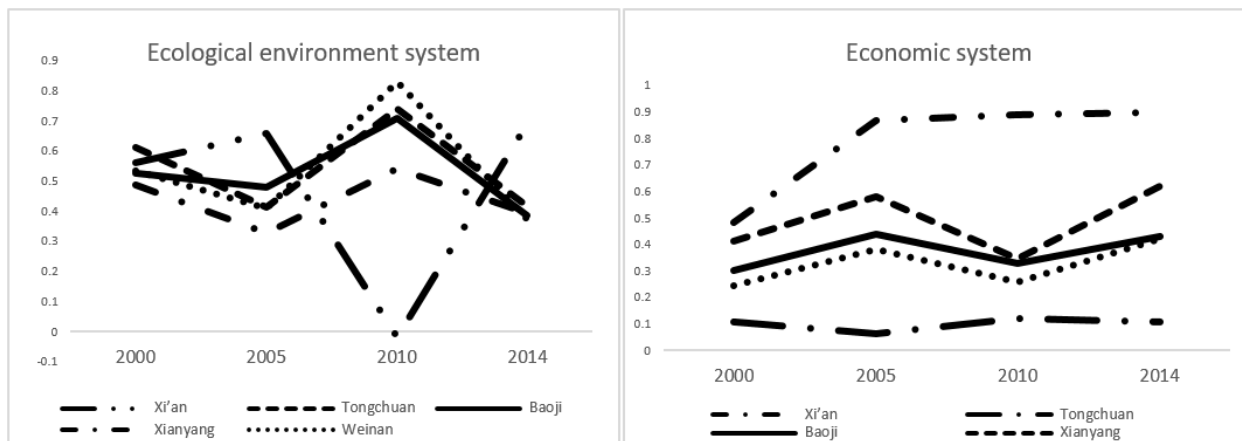


Fig. 1. Comprehensive evaluation index of eco-environment and economy systems in Guanzhong area

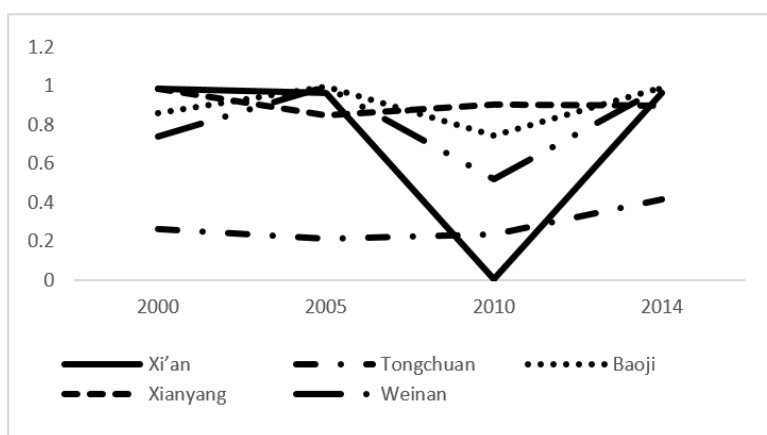


Fig. 2. Evolution trend of the coupling in time

in 2010. The comprehensive economic level of the cities in the Guanzhong area is clearly stratified, ranking: Xi'an, Xianyang, Baoji, Weinan, and finally Tongchuan.

In general, the evolution trend of the ecological environment in Guanzhong area is declining in the fluctuation; the main characteristics in the region are "V" type and inverted "V" type. The comprehensive development level of the economic system is low, and its evolution trend is rising in volatility; the development of various cities within the region is quite different.

Study of Time and Space Coupling Situation

Analysis of the time coupling situation

From the time series, the coupling relationship between the ecological environment system and the economic system in the Guanzhong area is mainly characterized by three major characteristics:

- (1) The overall evolutionary trend is rising in volatility. The evolution of the coupling degree in Guanzhong area showed an upward trend in the fluctuation. From 2000 to 2014, the degree

of coupling between cities and towns fluctuated significantly, showing an upward trend in fluctuations. The coupling degree of Tongchuan's two systems increased from 0.26 to 0.42, Baoji rose from 0.86 to 0.9, and Weinan's coordination increased from 0.74 to 0.9 (Fig. 2).

- (2) The phase characteristics are obvious. The phase characteristics of the coupling degree of the two major systems in Guanzhong area from 2000 to 2014 were significant. In the first stage (2000-2005), the development speed was slow, the coupling degree between Baoji and Weinan showed a slow rising speed, and Xi'an, Xianyang and Tongchuan showed a slow decline. In the second stage (2005-2010), the overall development speed was relatively fast. Xi'an, Baoji and Weinan experienced rapid decline. Xi'an had the lowest coupling degree in 2010. The overall development of the third stage (2010-2014) showed a rapid upward trend. The

Table 3. The coupling type and the coordination degree of the study area in different years

Region	2000	2005	2010	2014
Xi'an	0.719	0.857	0.052	0.857
Tongchuan	0.306	0.226	0.32	0.33
Baoji	0.597	0.676	0.622	0.637
Xianyang	0.667	0.621	0.632	0.675
Weinan	0.536	0.628	0.532	0.672

development speed is significantly faster than the first stage.

- (3) The evolution trend is characterized by a “V” shape. The “V” shape of the coupling between the eco-environment system and the economic system in Guanzhong area is characterized by significant changes. The coupling degree of the five prefecture-level cities showed a “V” trend with a decline and then a rise, and the year in which the lowest peak of each city appeared was inconsistent. Among them, Xi'an, Baoji and Weinan coupling degree “V” type change trend is obvious, the lowest peak appears in 2010; Xianyang and Tongchuan coupling degree “V” type change amplitude is small, the lowest peak appeared in 2005.

Analysis of the space coupling situation

From the perspective of space, the coupling relationship between the two major systems in Guanzhong area is characterized by two major characteristics:

- (1) It is divided into three major regional types. The coupling degree of Guanzhong area can be divided into three types. The first type is a high level of development, but the type of development is unstable, such as Xi'an. Xi'an has always been in the leading position in the Guanzhong area, taking the lead in reaching a high level of coupling type. The two systems have a high level of coordination, but there is instability. For example, in 2010, the contradiction between the ecological environment and economic development deteriorated, and low coordination and low level coupling occurred. The second type is good and stable development status, such as Xianyang, Baoji and Weinan. The coordination degree of these three cities is between 0.532 and 0.676, which is a good type of coordinated development. The development level is second only to Xi'an, and the evolution trend is relatively stable. The third type is low level of development and stable, such as Tongchuan. Tongchuan is at a disadvantage in the economic level of the entire Guanzhong area. Due to the lack of economic

support, the eco-environment system has not formed a good circular development model. Therefore, its coupling degree and coordination degree are in a disadvantaged position, the development level is low, and the development speed is slow. In recent years, the degree of development has improved to some extent, but there is still a certain gap compared to other cities.

- (2) Internal differences have gradually narrowed. With the change of time, the difference in the coupling type of Guanzhong area is gradually narrowing. In 2000, Xi'an, Xianyang and Baoji belonged to a high-level coupling type, and the coordination level of the two systems was very high; Weinan was a type of running-in, and the two systems developed more concord; Tongchuan was a low-level coupling and was at a level of reconciliation. In 2005, except for Tongchuan, which is a low-level coupling type, other cities have reached a high level of coupling. The types of coordination are high coordination (Xi'an), good coordination (Xianyang, Baoji and Weinan) and low coordination (Tongchuan). In 2010, Xianyang was a high-level coupling type, Baoji and Weinan were in a running-in state, and Xi'an and Tongchuan were low-level coupling types. Baoji, Xianyang and Weinan still maintain a good level of coordination, while Xi'an has the worst coordination and is at a low level of coordination. Tongchuan is at a moderate level of coordination. In 2014, Xi'an, Xianyang, Baoji and Weinan were all at a high level of coupling, and their coordination level was high; Tongchuan was antagonistic and in a basic state of coordination. In general, the coupling type has agglomeration characteristics, from three major types in 2000 to two major types in 2014; the level of coordination has increased, such as Tongchuan's low-level coupling from 2000 to 2014's antagonism, so the Guanzhong regional coordination level the overall development is towards a good trend.

CONCLUSION

- (1) The evolution trend of the comprehensive development index of the ecological environment in Guanzhong area is declining in fluctuations, and the economic evolution trend is rising in fluctuations. In the Guanzhong area, the ecological environment system and the economic system are not balanced and linear development, and the intra-regional development differences are more obvious. Superior economic conditions have not brought a higher level of environmental resilience to the city. Once the ecological environment is unstable, the two systems are facing imbalances at any time, such as Xi'an; correspondingly, the disadvantage of the economic level does not better promote the virtuous cycle of the ecosystem, and it is fluctuating, such as Tongchuan.
- (2) The time-coupling development trend characteristics of the two major systems in Guanzhong area are mainly manifested in: the overall evolution trend of the region rises in the fluctuation, the phase characteristics of the domain are obvious, and the "V" type evolution trend. There are two characteristics of the spatial coupling development of the two major systems in Guanzhong. First, the Guanzhong area is mainly divided into three major regional types. The first type of coupling degree is high in development but unstable, such as Xi'an. This is because since the reform and opening up, Xi'an has been developing along a comprehensive track, coordinating the ecological environment and economic and social development, and basically achieving coordinated and sustainable urban development. However, in the two major systems of development, the allocation of resources is not reasonable, and the urban development mechanism has unstable factors. The second type of coupling is coordinated and stable, such as Xianyang, Baoji and Weinan. The third type of coupling degree is low and stable, such as Tongchuan; the difference in internal coupling degree of the second region is gradually reduced, and it is developing in a good coordination direction. Therefore, while developing the economy, focusing on ecological environment protection and investment support is a necessary way for regional sustainable development.
- (3) In view of the overall development of the region and its internal development, this study proposes some countermeasures and suggestions from the macro and micro aspects, so as to accurately locate its development direction and improve the overall level and competitiveness of the region. From a macro perspective, the overall development level of the Guanzhong area is low at this stage. In 2014, the eco-environment comprehensive benefit score was 0.45, and the economic development benefit score was 0.50. The coupling and coordination of the two systems are moving in a benign direction, but there are still some problems within the system. The environmental pollution level of the eco-environment system has a high weight of industrial exhaust emissions, and the comprehensive treatment of atmospheric environmental pollution has become the top priority of sustainable development in Guanzhong area; In the environmental prevention level, the weight of domestic garbage removal is the lowest, indicating that the regional comprehensive efforts on solid waste management are insufficient. Therefore, it is necessary to improve the urban ecological environment, improve the utilization efficiency of solid waste, reduce resource consumption, and classify and recycle waste. In the economic system, the secondary industry, especially the industry, has become an important pillar supporting economic development, while the tertiary industry has a small proportion of weight. As the Guanzhong area has an important historical status and rich tourism resources, its cultural tourism as a major growth pole in the Guanzhong area can not only increase the income of residents, but also slow down the damage caused by some high-energy-consuming industries. In terms of social livelihood, the per capita disposable income of urban residents is high, and the per capita net income of farmers is low. This requires strengthening new urbanization, realizing urban-rural integration, increasing farmers' income, and narrowing the gap between the rich and the poor.

From the micro level, Xi'an, as the leading city in Guanzhong area, relies on the Eurasian Continental Bridge to play a leading role in the development of Shaanxi Province and the development of the western leaps and bounds. The two systems in Xi'an have higher

comprehensive scores and high degree of coordination, but there are unstable factors, and the two systems in Xianyang are stable. Therefore, the integration of Xi'an and Xianyang will be strengthened, the city will be optimized and reorganized, the pattern will be expanded, and fresh blood will be added to Xi'an, so that Xi'an will assume the heavy responsibility of the western economic, financial, commercial, information and science and education centers. The comprehensive capacity of Baoji's two systems is at a medium level. As a sub-central city in Guanzhong, convenient transportation and a strong industrial base provide favorable conditions for the development of Baoji. With one of China's top ten ecologically livable cities, known as "the hometown of Yan Emperor, the hometown of bronzes, the holy land of Buddhism, and the hometown of social fires", Baoji should keep the secondary and tertiary industries in parallel and form a high-level ecological and civilized green city; Weinan is an important commodity agricultural base in China. Therefore, it optimizes the processing of agricultural and sideline products and forms a characteristic ecological recycling agricultural development path. Due

to the rich tourism resources, the national historic city (Hancheng) and the national scenic spots (Huashan) can be used to promote the brand. Create a regional linkage strategy for the Qin, Jin, and Yuhuanghe Gorge tourist areas centered on Huashan, and finally achieve a sustainable development path; as a typical resource-based city, Tongchuan has a prominent historical accumulation problem. Therefore, strengthen the construction of the circular economy industrial chain, implement industrial transformation and focus on alternative industries. Focus on the construction of coal resource comprehensive utilization industrial chain and coal ecological restoration demonstration zone to realize the cascade utilization and recycling of resources and energy. At the same time, we will continue to increase the scale of alternative industries and industrial concentration, and foster new economic growth points in Tongchuan. Therefore, we must base ourselves on our own advantages and vigorously develop cultural tourism, health care and health care industry, advanced equipment manufacturing, biomedicine, new materials, agricultural and sideline products processing industries, and form a diversified industrial structure.

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