

Retraction

Retracted: A Dynamic Econometric Analysis of Urbanization and Ecological Environment in Silk Road Economic Belt

Scientific Programming

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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- [1] X. Li and F. Luo, "A Dynamic Econometric Analysis of Urbanization and Ecological Environment in Silk Road Economic Belt," *Scientific Programming*, vol. 2022, Article ID 4895213, 8 pages, 2022.

Research Article

A Dynamic Econometric Analysis of Urbanization and Ecological Environment in Silk Road Economic Belt

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On the basis of the construction of urbanization and ecology index system, this study takes the core area of Silk Road Economic Belt, Gansu, as the research object and creates the coordination evaluation model between urbanization and ecological environment in Gansu; meanwhile, it uses BP neural network to predict the coordinated development of urbanization and ecology in Gansu Province. Finally, the aforesaid model is validated by means of empirical evidence. The results show that Gansu, in the Silk Road Economic Belt, has accelerated its urbanization level in the 10-year period from 2010 to 2019 in the context of the Belt and Road Initiative, especially in Jiayuguan and Lanzhou, mainly due to its industrialization-led urbanization; meanwhile, in terms of coupling degree, most of them are between 0.45 and 0.55, and most of them are out-of-frequency pro-disorder recession type, indicating that under the background of urbanization, the ecology of each city and prefecture in Gansu is also under great pressure. At the same time, through the forecast, Gansu is considered to be in the red light in 2019, as the endangered disorder recession B environmental lagging type, indicating that Lanzhou is facing great ecological pressure, but in general, the relationship between human and land is gradually developing in harmony.

1. Introduction

Urbanization involves multiple elements such as population, economy, and society, and large-scale migration of population, change in production, lifestyle, and land use occur during the urbanization process. The urbanization level of China was only 19.39% in 1980, and after that, driven by the policy of reformation and opening, the urbanization process of China has been accelerating and by 2020 it has risen to 63.89%, with a total of 687 cities and towns nationwide [1–5]. Accelerated urbanization has also caused multiple problems, including climate change, waste of resources, and ecological degradation, which pose serious challenges to the modernization of our economy and society. For example, Huang Jinchuan developed a coupling harmonious degree model to quantitatively define the level of ecology, the level of

urbanization, and the coupling between the two systems in Kazakhstan and confirmed that ecological factors such as ecological land per capita, arable land area per capita, forest cover, and per capita available resources play a key influence on the degree of coupling coordination between urbanization and ecology in Kazakhstan [6]; by means of a case study, Zhenfeng Shao first established a special comprehensive evaluation index system, then invoked the entropy-weighted TOPSIS technique for comprehensive evaluation, and found that the coupling coordination degree of urbanization and ecology in the Yangtze River Delta region maintained an incremental trend, changing from an unbalanced state in 2008 (0.604) to a basically balanced state in 2017 (0.753) [7]. Zheng Ji conducted extensive social research on urbanization in the Russian Far East and found that Russia's increasing investment in urbanization in the Far East has improved the coupling

coordination degree between urbanization and ecological environment, from a slight imbalance at the beginning of the survey to a barely balanced state at present [8]. This study focuses on Gansu Province, the central core of the Silk Road, as the research area, and integrates machine learning prediction method and quantitative analysis to assess the coordinated development of urbanization and ecology in Gansu Province, hoping to provide reference for the future development strategy of Gansu Province, to improve the status of Gansu Province in the Silk Road Economic Belt.

1.1. Establishment of the Assessment Indicator System for the Coupling Degree of Urbanization and Ecology

1.1.1. Principles for Constructing the Indicator System. The construction of evaluation indicators should consider the diversity of indicators and the correlation between indicators, to build a scientific and reasonable indicator system for appraising the coordination between urbanization and ecology. Therefore, the index system built by this study also follows the following principles [9–11].

First, the principle of comprehensiveness: as two typical integrated systems, attention should be paid to the comprehensiveness of the selected indicators when constructing the indicator system. Among them, the level of urbanization is reflected in four aspects: population, economy, society, and space, and the ecology level is reflected in three aspects: state, pressure, and response. The selected indicators should cover these aspects comprehensively.

Second, the principle of scientificity: to objectively reflect the essential properties of things, we should choose some common general indicators and some special indicators according to the actual local situation. This will ensure that the constructed index system is scientific in nature.

Third, representativeness principle: the indexes that can reflect the level of urbanization and the quality of living conditions are relatively abundant, but there are correlations among many of them, which require that when constructing the indicator system, the most representative indicators should be selected from the many correlated indicators, and these indicators have the best evaluation effect.

Fourth, the principle of operability: the indicators selected into the indicator system must be able to easily obtain the indicator data, to ensure that the indicators have practical significance; on the contrary, if the indicator data are not available or difficult to obtain, the indicator system will lose its value of existence. Therefore, the availability of data is considered in the selection of indicators, to ensure that the established indicator system is operable.

1.2. Urbanization Indicator System. With the definition of “urbanization” in urban geography as the support, the level of urbanization is comprehensively evaluated in four aspects [12–17], including population, economy, space, and society;

the ecological pressure is evaluated in three aspects, including ecological pressure (Y1), ecological state (Y2), and ecological response (Y3). The overall evaluation indicator system is presented in Table 1.

2. Research Methods

2.1. Evaluation Model Construction of Coupling Coordination Development between Urbanization and Ecology

2.1.1. Comprehensive Level Evaluation Model. To assess Gansu’s comprehensive level, which is the key Economic Belt of the Silk Road, the comprehensive level evaluation model of (1) is used to measure the level of coordinated development of urbanization and ecology in Gansu during 2010–2019.

$$Y_{i2} = \sum_{j=1}^{20} A_{ij} * W_{ij} \quad (i = 1, 2, 3, \dots, 10\text{Year}),$$

$$Y_{i1} = \sum_{j=1}^{20} A_{ij} * W_{ij} \quad (i = 1, 2, 3, \dots, 10\text{Year}),$$
(1)

where Y_{i1} denotes the comprehensive evaluation level of urbanization in year i ($i = 1, 2, 3, \dots, 20$); Y_{i2} denotes the comprehensive evaluation level of ecological environment in year i ($i = 1, 2, 3, \dots, 10$); and A_{ij} indicates the standardized value of the j th index in year i .

2.1.2. Coupling Degree Model. To better represent the degree of disorder among the urbanization subsystem and the ecology subsystem in Table 1, the coupling degree model of (2) is introduced [18] as follows:

$$C_n = \left(\frac{U_1 * U_2 * \dots * U_m}{\prod(U_i + U_j)} \right)^{1/n}. \quad (2)$$

According to (3), U_1 is equivalent to Y_{i1} and U_2 is equivalent to Y_{i2} . When $n = 2$, then there is a coupling degree function of urbanization and ecology, as follows:

$$C = \left[\frac{Y_{i1} * Y_{i2}}{(Y_{i1} + Y_{i2})^2} \right]^{1/2}. \quad (3)$$

2.1.3. Coupling Coordination Development Model. The coupling degree can only reveal the closeness degree, i.e., development order, between the two systems of urbanization and ecology, but cannot confirm the coordination effect among the two systems. In this regard, it is necessary to characterize this by invoking the coupling coordination development degree shown as follows:

$$\begin{cases} D = (C * T)^{1/2}, \\ T = \alpha Y_{i1} + \beta Y_{i2}, \end{cases} \quad (4)$$

where C indicates the coupling degree of urbanization and ecology; D indicates coupling coordination development degree; T denotes the composite reconciliation index,

TABLE 1: Evaluation system of coupling coordination between urbanization and ecology.

Project	First-grade index	Second-grade index	Impact
Urbanization subsystem X	Population urbanization (X1)	Urban population (ten thousand)	X11 +
		Proportion of urban population (%)	X12 +
		Proportion of employed persons in secondary industry (%)	X13 +
	Space urbanization (X2)	Area of built-up area (km2)	X21 +
		Urban road area per capita (square meters)	X22 +
		Urban population density (persons/km2)	X23 +
	Economic urbanization (X3)	GDP per capita (yuan)	X31 +
		Proportion of secondary industry (%)	X32 +
		Proportion of tertiary industry (%)	X33 +
		Value-added of secondary industry per capita (ten thousand yuan)	X34 +
		Value-added of tertiary industry per capita (ten thousand yuan)	X35 +
		Total industrial output value per capita (ten thousand yuan)	X36 +
		Engel coefficient (%)	X41 -
	Social urbanization (X4)	Proportion of urban medical insurance participants (%)	X42 +
Number of beds in health institutions (piece)		X43 +	
City gas penetration rate (%)		X44 +	
Ecological environment subsystem(Y)	Eco-environmental stress (Y1)	Per capita industrial solid generation (t)	Y11 -
		Industrial sulfur dioxide emissions per capita (t)	Y12 -
		Industrial wastewater emissions per capita (t)	Y13 -
	Eco-environmental state (Y2)	Proportion of air quality reaching grade 2 or above (%)	Y21 +
		Green coverage rate of built-up areas (%)	Y22 +
		Disaster area (kkm2)	Y23 -
	Eco-environmental response (Y3)	Industrial wastewater treatment rate (%)	Y31 -
		Comprehensive utilization rate of industrial solid waste (ten thousand tons)	Y32 +
		Urban sewage treatment rate (%)	Y33 +
		Domestic waste delivering quantity (ten thousand tons)	Y34 +

$T \in (0, 1)$; and α and β are undetermined coefficients, $a = 0.5, \beta = 0.5$.

In addition, this study classifies the harmonious development status of urbanization and ecology into three grades: unacceptable interval (0–0.4); excessive interval (0.4–0.6); and acceptable interval (0.6–1.0).

2.2. Coordination Evaluation Model Construction of BP Neural Network

2.2.1. *Structure of BP Neural Network.* In order to better coordinate the relationship between urbanization and ecology in the Gansu region, based on the measurement of coupling coordination degree, the coordinated development of urbanization and ecology in the Gansu region of the Silk Road Economic Belt is predicted by using the BP neural network, which can provide more reference for the development of the Silk Road Economic Belt. The BP neural network structure is presented in Figure 1 [19–22].

In the structural system shown in Figure 1, neighboring levels are linked by nodes, and nodes within the same level and between different levels can also interact with each other, but a node can only exert influence on a node in the next level. Therefore, based on this principle, the BP neural network first analyzes and organizes the input historical data and passes them downward step by step until output results. The output value is compared with the ideal value, and if the difference between them is greater than some set error, the inverse

adjustment is executed to find the error upward step by step, and finally, a reasonable sample is selected and the weights are updated. The above process is repeated, and finally, the result that meets the accuracy requirement is output.

The above process is sorted out and refined into three steps as follows:

- (1) Determine the input data of the nodes in the hidden layer R_j :

$$R_j = \sum_{i=1}^n w_{ij} - \theta_j, \quad (j = 1, 2, \dots, p), \quad (5)$$

where p denotes the number of neural nodes in the hidden layer and θ_j denotes the range value of neuron j in the hidden layer.

- (2) Determine the output data for each node in the hidden layer Z_j :

$$Z_j = f(R_j) = \frac{1}{1 + e^{-R_j}}, \quad (j = 1, 2, \dots, p). \quad (6)$$

- (3) Determine the model output values for the output layer.

2.2.2. *A Coordination Forecasting Model Based on BP Neural Network.* To better analyze the Gansu region in the Silk Road Economic Belt, BP neural network is applied to predict

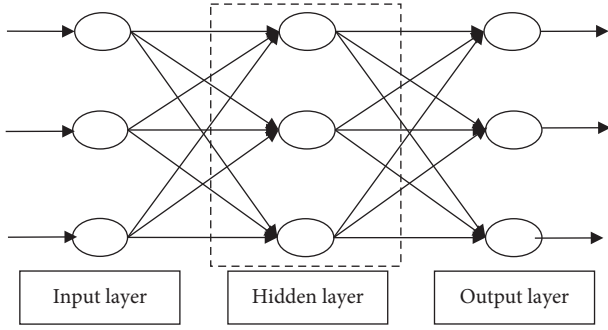


FIGURE 1: BP neural network structure.

the coordination degree of urbanization and ecology, which consists of the following 3 steps:

- (1) Sample classification: the base data are standardized for extreme differences, and the appropriate amount of sample data is randomly chosen to form the training sample, while the remaining data are formed into the test sample.
- (2) Network design: the number of neurons in the input layer, output layer, and hidden layer is set to 5, 1, and 11, respectively. The network training target is set to $1e^{-6}$, the momentum constant is 0.8, the maximum number of network training is 5000, and the learning rate is 0.1. The “tansig” function and the “logsig” function are selected for the hidden layer and output layer transfer functions, respectively.
- (3) Network training: the network is trained using training samples until the optimal number of training times.

3. Method Validation and Result Analysis

To verify the feasibility and scientificity of the above methods, a combination of empirical evidence and simulation is used to validate the above model.

3.1. Data Source. From the Gansu Development Yearbook (2010–2019), the China City Statistical Yearbook (2010–2019), the official website of the National Bureau of Statistics, and the Gansu Provincial Economic Information Network, we obtained 30 sets of relevant data for Gansu Province during 2010–2019 as the base data.

3.2. Data Preprocessing. The base data need to be standardized for extreme differences by the following formula, to eliminate the effects of the difference in dimension and magnitude [23–25]:

$$A_{ij} = \frac{\max(X_{ij}) - X_{ij}}{\max(X_{ij}) - \min(X_{ij})} (X_{ij} \text{negative indicator}), \quad (7)$$

$$A_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})} (X_{ij} \text{positive indicator}).$$

Here, $\max(X_{ij})$ and $\min(X_{ij})$ indicate the maximum and minimum values of the j th indicator data in year i of each region, respectively; X_{ij} indicates the original data of the j th indicator in year i ; and A_{ij} indicates normalized value by the extreme difference.

In addition, the index weights are derived by the entropy weight method, which is based on the idea that the greater the entropy of information, the more information there is, and vice versa. The entropy weight method is calculated by the formula [26]:

$$W_{ij} = \frac{1 - H_{ij}}{\sum_{j=1}^m (1 - H_{ij})} W_i = 1, \quad (8)$$

$$H_{ij} = -\frac{1}{\ln(n)} \sum_{j=1}^m P_{ij} \ln(P_{ij}) (n = 14),$$

where H_{ij} indicates the entropy value of the j th index in year i and W_{ij} denotes the weight of the j th indicator in all indicators in year.

3.3. Evaluation Results

3.3.1. Integrated Level Assessment of Urbanization Subsystems. After solving the weights of each indicator in the urbanization subsystem, the comprehensive evaluation level of urbanization of each region during the survey period is determined by weighting and summing them with the standard values of each indicator. The specific results are illustrated in Figure 2.

From the growth rate of urbanization development, Jiayuguan is a city with the highest urbanization level and the fastest growth rate of urbanization in Gansu Province, mainly due to its more mature industrial base under the Silk Road Economic Belt, and the fact that Jiayuguan is a prefecture-level city without a municipal district, with a smaller urban area, regional economy, and urban population, which ultimately shows a higher level of urbanization; the urbanization level of Lanzhou City ranks second. It is the capital city of Gansu Province and has comparative advantages in terms of economic development, transportation facilities, geographical location, and public infrastructure driven by the Silk Road Economic Belt, so it has more room for future development and a more rapid urbanization rate.

In terms of location, the urbanization level of the area north of Lanzhou is greater than that of the area south of Lanzhou. The reason is that cities north of Lanzhou, such as Jiuquan, Baiyin, Zhangye, Wuwei, and Jinchang, are mostly energy-based cities, and industrialization has driven urbanization, so the urbanization level of these cities is overall higher than that of cities south of Lanzhou. Among the regions south of Lanzhou, Tianshui has the highest level of urbanization, which is mainly due to its advantages of economic development, geographical location, and climatic conditions under the Silk Road Economic Belt. Besides, under the Silk Road Economic Belt development, the cities of Longnan, Dingxi, Gannan, Pingliang, and Linxia Prefecture have lower urbanization

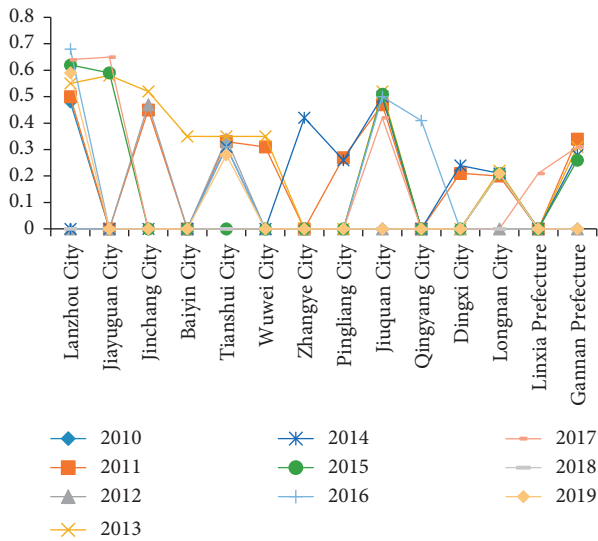


FIGURE 2: Assessment results of comprehensive level of urbanization subsystems.

levels restricted by the natural environment and geographical location.

3.3.2. Comprehensive Level Evaluation of Ecological Environment. Similarly, the comprehensive evaluation level of ecological environment of each region during the survey period was determined by the method of Section 3.3.1, and the specific results are illustrated in Figure 3.

As shown in Figure 3, Lanzhou is a city with an overall high level of ecological environment in Gansu Province; particularly, after the national Belt and Road Initiative was proposed, Lanzhou City has vigorously tackled the air pollution problem through coal-to-gas policy, energy structure adjustment policy, etc., and relocated Lanzhou Petrochemical to Lanzhou New District. These initiatives have controlled the coal-fired dust at source and also significantly reduced industrial waste emissions, making the ecological environment level in Lanzhou City climb rapidly; the integrated level of ecological environment in Baiyin has increased from 0.38 in 2010 to 0.54 in 2019, which is the largest increase and shows the efforts made by Baiyin in ecological environment protection; Jiayuguan and Jinchang are lagging behind in the overall ecological environment ranking because they are located in the western part of Gansu Province, the ecological environment is fragile, natural conditions are extremely poor, and industry is their pillar industry, so urbanization has caused heavy pressure on the ecological environment. Located in southern Gansu, Longnan City has relatively good natural conditions, but by geographical factors and economic level constraints, Longnan City will be mainly devoted to urbanization development business, resulting in its ecological environment comprehensive level being low. The ecological environment level of the remaining cities and states fluctuates around 0.6, and the level of urbanization is lower than its ecological environment level, and the level of urbanization and

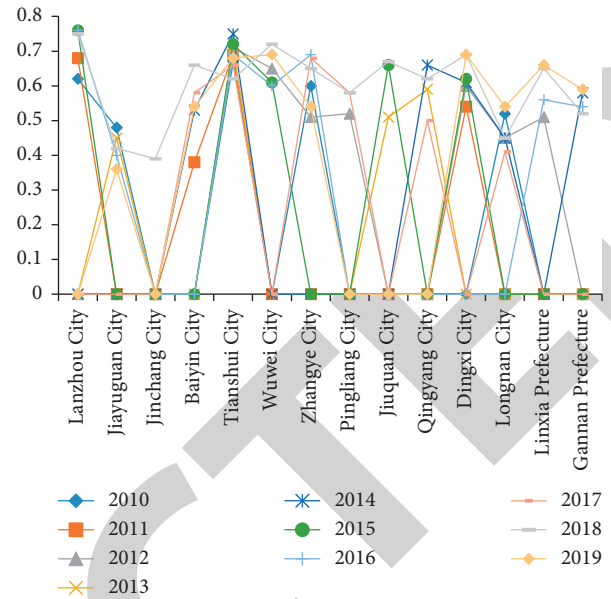


FIGURE 3: Assessment results of the comprehensive level of ecological environment.

ecological environment development does not match each other.

3.3.3. Coupling Coordination Development Degree Analysis. According to (4), as well as combining the relevant data in Figures 1 and 2, the coupling degree of urbanization and ecology of each city in Gansu is measured. The results are illustrated in Figure 3.

Combined with Figure 4, it is seen that except for Jiayuguan, Lanzhou, Qingyang, and Jiuquan, the degree of coupling coordination development of urbanization and ecology in other cities and states is in the excessive range.

3.4. Coordination Degree Prediction Results of BP Neural Network

3.4.1. Determination of Early Warning Limits. To better predict the development level of coordination degree in Gansu in the Silk Road Economic Belt, the data in Figure 3 are used as the basis, and the coordination degrees measured in the previous 7 years are used as the training data, and the coordination degree data measured in 2017, 2018, and 2019 are used as the test data for prediction. At the same time, to judge the development of Gansu cities and states, early warning limits are set to divide the level of coordination degree of urbanization and ecology. Referring to the previous discussions and combining with the calculation results of this study on the coordination degree of urbanization and ecology, the warning limit division interval in Table 1 is determined, where C represents noncooperative scheduling.

Table 2 shows that as the warning light transitions from “blue light” to “red light,” it means that the coordination between urbanization and ecology is deteriorating, changing

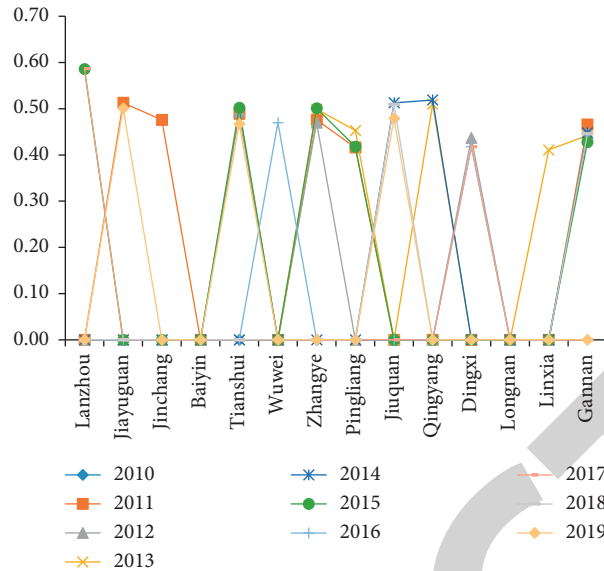


FIGURE 4: Coupling coordination degree measurement results.

TABLE 2: Early warning limit division.

Warning limit (C)	$0 < 0.4$	$0.4 \leq 0.5$	$0.5 \leq 0.7$	$0.7 \leq 0.8$	$0.8 \leq 0.9$	$0.9 \leq 1$
Alert	Mega	Heavy	Medium	Light	Micro	No
Signal light	Red	Yellow	Light green	Green	Light blue	Blue
Coordination status	Severe dissonance	Moderate dissonance	Barely coordinated	Moderately coordinated	Good coordination	Quality coordination

from quality coordination in the no-alarm state to serious imbalance in the mega-alarm state.

3.4.2. Results and Analysis

(1) *BP Analysis Results.* Based on the above data, the neural network toolbox of MATLAB was used. The coordination data of Lanzhou, Jiayuguan, and Jinchang cities were input into the trained BP network, and the prediction results in Table 3 were obtained.

(2) *Analysis of BP Prediction Results.* Based on the same method as above, the early warning signals for the coordinated development of urbanization and ecology in Gansu between 1992 and 2010 are listed in Table 4.

The analysis shows that the prediction results are that the early warning signal of Gansu in 2017 and 2018 is the green light, when urbanization remains moderately coordinated with the ecological environment, and a red light in 2019. It can be expected that under the background of the Silk Road Economic Belt development, the urbanization process in Gansu will continue to accelerate, with numerous rural laborers flocking to the city. While accelerating the urbanization process, it has also caused more serious production and domestic pollution. In addition, the urban population explosion will cause a variety of problems such as insufficient urban domestic water, deterioration of urban domestic water quality, deterioration of urban air quality, and shrinking of

TABLE 3: BP network prediction results.

	Lanzhou	Jiayuguan	Jinchang
Sample value	0.57	0.50	0.46
Predicted value	0.56	0.49	0.45
Relative error (%)	3.31	1.45	1.69

TABLE 4: Prediction results.

Year	2017	2018	2019
Early warning signal	Green	Green	Red

urban green space per capita, leading to further deterioration of the coordination between urbanization and ecology.

4. Conclusion

The above study suggests that the coordinated development of Gansu in the Silk Road Economic Belt in recent years has been evaluated in a quantitative manner. The results indicate that the coupling degree of urbanization and ecology in most cities and states in Gansu Province fluctuates above and below 0.48, with a small gap between them, while urbanization brings certain negative effects to the ecological environment; the data from 2010 to 2019 are also used as the basis for predicting the coordinated development level of urbanization and ecology in Gansu, the key region in the Silk Road Economic Belt. The results also show that urbanization

has accelerated damaging ecological environment. The above study provides both quantitative analysis and prediction, which provides a new reference for the development of Gansu, a core region of the Silk Road Economic Belt.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding this work.

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