Evaluation of Land Ecological Security in Chengdu Based on DPSIR-Comprehensive Index Model

Li Zhu

Department of Management, Sichuan Agricultural University, Chengdu, Sichuan, 611130, China

Keywords: Land Ecological Security Assessment; DPSIR Model; Grey Correlation Method; Comprehensive Index Model

Abstract: Based on the DPSIR model, the land ecological security evaluation index system is established. The gray correlation method is used to obtain the weight of each index. The comprehensive index method is used to calculate the comprehensive ecological security index of Chengdu from 2006 to 2015, and the trend is analyzed. The results show that: (1) The ecological security status of Chengdu has been improved, the land ecological comprehensive index has increased by 0.0285, and the safety level has risen from sensitive to good. (2) The comprehensive index of land ecological security in Chengdu is close to the critical value of good and sensitive levels, and there is still tremendous pressure on the protection of land ecological security. (3) The land ecological status and response safety index are the main influencing factors of the comprehensive index. The land production and service status can be improved by improving the quantity and quality of the land. It is also possible to increase the land ecological protection investment through policy, economic and technical means to improve the land ecology security status.

1. Introduction

In recent years, the rapid advancement of urbanization and industrialization predicts that China's urbanization rate will reach 70% by 2030 [1], which will intensify the contradiction between people and land while increasing the degree of land use, and aggravate the land environment such as land pollution and desertification in China. The problem, in turn, affects the ecological security of the land and hinders the sustainable development of the social economy [2]. Therefore, solving the problem of land ecological security is an important issue in the rapid development of the economy today, and its basic research is the scientific evaluation of land ecological security. As an important cultural, financial and transportation hub in Southwest China, Chengdu can scientifically evaluate its land ecological security, which not only ensures the simultaneous development of Chengdu's economy and ecology, but also provide a solid land resource base for economic development and social stability in the western region.

It is the fundamental purpose of land ecological security evaluation to evaluate the impact of the current state of service function of land ecosystem and its changing trend on socio-economic and agricultural production development by quantitative means [3-4].The construction of the evaluation index system and the determination of the index weight are the basis for the evaluation of land ecological security. The scientific evaluation method can guarantee the scientific and accurate evaluation results. Based on the PSR model, some scholars use entropy method and analytic hierarchy process to determine the weight, and then use the comprehensive index method, matter element method or CMP model to obtain the evaluation model [5-7]. Some scholars have combined the DPSIR model with the TOPSIS model to evaluate land ecological security [8]. With the development of spatial geographic information system, some scholars have introduced the GIS grid model into the land ecological evaluation, and carried out spatial evaluation of the ecological security problem of Yinchuan City from the micro grid scale [9]. After comprehensively considering various models, combined with the research purpose and the availability of actual data, this study will adopt the DPSIR-composite index combined model, and use the gray correlation method to obtain the weight to evaluate the land ecological security of Chengdu from 2006 to 2015.

  DOI: 10.25236/eeems.2018.029

And based on the evaluation results to provide effective advice for Chengdu's land ecological security.

2. Data Source and Processing

2.1 Data source

This paper studies the annual data of Chengdu Statistical Yearbook (2016-2007), Sichuan Statistical Yearbook (2016-2007), and China Statistical Yearbook (2016-2007) to obtain the research needs of Chengdu 2006-2015. Relevant initial data.

2.2 Data Processing

(1) Index safety index calculation

In order to calculate the safety index of each indicator, it is first necessary to establish the benchmark value of each indicator, which mainly comes from the internationally recognized value, the world average or the national average. The benchmark value of some indicators considers the characteristics of the land ecological environment of Chengdu and Under the premise of the actual situation, the average level of Sichuan Province is adopted. See Table 1 for details.

Table 1 Benchmark values of Chengdu's land ecological security assessment indicators

Index	Reference value	Source	Nature of the indicator
Natural population growth rate ($0/_{00}$)	5.002	National average	-
Urbanization rate (%)	50	Ecological city standard	-
10,000 yuan GDP energy consumption (t standard coal)	0.9	Ecological city standard	-
Industrial output value as a percentage of GDP (%)	39.07	National average	-
GDP per capita (yuan/person)	332223	National average	+
Population density (person/square kilometer)	128	International standard	-
Pesticide area per unit of cultivated land (kg/m^2)	0.001281494	National average	-
Unit of cultivated land area fertilizer use (kg/m^2)	0.025	Ecological city standard	-
The area of cultivated land per unit of agricultural film (kg/m^2)	0.001928907	National average	-
Industrial wastewater discharge / tons	208213.01	Sichuan average	-
Industrial waste gas emissions / billion standard cubic meters	15531.80423	Sichuan average	-
Per capita cultivated area (m^2/person)	530	Internationally recognized value	+
Area of construction land (m^2/in)	24.55770399	Sichuan average	-
Effective irrigation accounts for the proportion of cultivated land (%)	0.532458294	Sichuan average	+
Unit land area wastewater carrying capacity (kg/m^2)	4.293052	Sichuan average	+
Unit land output value (yuan/m^2)	3.979938557	Sichuan average	+
Unit cultivated land grain production (kg/mu)	514.1338259	Sichuan average	+
The proportion of the tertiary industry (%)	45	Ecological city standard	+
The proportion of farmers' agricultural income (%)	50	Western region average	+
Per capita park green area (m^2/person)	12	Ecological city standard	+
Industrial wastewater discharge rate (%)	100	Internationally recognized value	+
Industrial solid waste comprehensive utilization rate (%)	90	Ecological city standard	+
Afforestation area (hectare)	285924.2	Sichuan average	+
Environmental protection investment as a percentage of GDP (%)	3.5	Ecological city standard	+
Whole society fixed assets investment (ten thousand yuan)	146333570	ichuan average	+

Note: “+” means positive indicator and “-” means negative indicator.

According to the benchmark station set in this paper, the actual value of each year's index is calculated, and then its safety index is obtained. For the forward indicator, when the calculated actual value x_j is not less than its reference value z_j ($x_j \geq z_j$), its safety index $p_i=1$; when its actual value x_j is smaller than the index reference value zj($x_j < z_j$) Its safety index is $p_i=x_j/z_j$. For the negative indicator, when the actual value xj is not greater than the index reference value z_j($x_j \leq z_j$), its safety index $p_i=1$; when its actual value xj is smaller than the index reference value z_j($x_j > z_j$), Its safety index is p_i=zj/xj.

(2) Standardization of actual values

In order to ensure the comparability of different indicators to obtain their weight, the dimensionless (standardization) treatment of the original data is the basis for the evaluation of Chengdu's land ecological security. For the positive indicator, the method of Equation 1 is standardized, and for the negative indicator, the method of Equation 2 is used for standardization. See the following formula for details.

$$y_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)} \tag{1}$$

$$y_{ij} = \frac{\max(x_j) - x_{ij}}{\max(x_j) - \min(x_j)} \tag{2}$$

Where xij and y_{ij} represent the original value and the normalized value of the jth index of the i-th year, respectively, and max(x_j) and min(x_j) represent the maximum and minimum values of the j-th index.

3. Research Methods

3.1 Establishing an indicator system based on the DPSIR model

The establishment of the indicator system is the basis for evaluating the ecological security status of Chengdu's land, and it must be able to comprehensively reflect the interrelationship between its socio-economic development and land ecological security. The DPSIR model expands its indicator criteria layer into five aspects: “driving force-pressure-state-impact-response” [10], which can better reveal the causal relationship between human life, production and economic activities on land ecological security. Under the impetus, it exerts pressure on the ecological security of the land, which in turn changes the physical, chemical and biological state of the land. The change has affected the human production and life to a certain extent, and thus humans have responded to it and thus the land. Feedback on the driving force, pressure and status of ecological security, as shown in Figure 1.

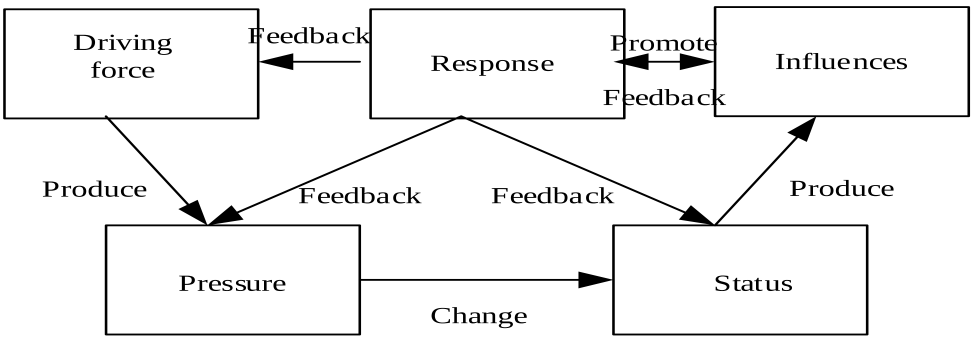

Fig. 1 DPSIR model connotation map

Relying on the basic requirements of representativeness, integrity and scientificity of indicators in the connotation of DPSIR model, according to the social and economic development status, ecological environment and land use situation of Chengdu, and referring to the research results of previous scholars [11-12], based on 25 evaluation indicators were selected for population growth, social economic development, and agricultural industrial progress on land quality, quantity, and ecological environment. See Table 2 for details. T

Table 2 Chengdu Urban Land Ecological Security Evaluation Index System and Weights

Target layer	Criteria layer	Indicator layer	Weights	Nature of the indicator
Land ecological security	Driving force	Natural population growth rate ($0/_{00}$)	0.0506	-
		Urbanization rate (%)	0.0394	-
		10,000 yuan GDP energy consumption (t standard coal)	0.0385	-
		Industrial output value as a percentage of GDP (%)	0.0370	-
		GDP per capita (yuan/person)	0.0390	+
	Pressure	Population density (person/square kilometer)	0.0395	-
		Pesticide area per unit of cultivated land (kg/m^2)	0.0471	-
		Unit of cultivated land area fertilizer use (kg/m^2)	0.0500	-
		The area of cultivated land per unit of agricultural film (kg/m^2)	0.0383	-
	Status	Industrial wastewater discharge / tons	0.0484	-
		Industrial waste gas emissions / billion standard cubic meters	0.0365	-
		Per capita cultivated area (m^2/person)	0.0357	+
		Area of construction land (m^2/in)	0.0400	-
		Effective irrigation accounts for the proportion of cultivated land (%)	0.0333	+
	Influences	Unit land area wastewater carrying capacity (kg/m^2)	0.0483	+
		Unit land output value (yuan/m^2)	0.0386	+
		Unit cultivated land grain production (kg/mu)	0.0357	+
		The proportion of the tertiary industry (%)	0.0323	+
		The proportion of farmers' agricultural income (%)	0.0357	+
	Response	Per capita park green area (m^2/person)	0.0388	+
		Industrial wastewater discharge rate (%)	0.0465	+
		Industrial solid waste comprehensive utilization rate (%)	0.0381	+
		Afforestation area (hectare)	0.036	+
		Environmental protection investment as a percentage of GDP (%)	0.0349	+
		Whole society fixed assets investment (ten thousand yuan)	0.0417	+

Note: The higher the value of the positive indicator indicated by “+”, the smaller the value of the negative indicator indicated by “-”, the safer the land ecology.

3.2 Grey correlation method to obtain index weights

In the evaluation system, the degree of influence of each evaluation index on the target layer is different. Therefore, the determination of the weight of each index often has a direct impact on the evaluation results. The grey correlation method calculates the numerical relationship between the subsystems by calculating the degree of gray correlation between them, and realizes the effective quantitative measurement of the development trend of the system. The connotation of land ecological security is systematic, including space and time. The weight determined based on the gray correlation degree can also be effective while avoiding subjective arbitrariness caused by subjective evaluation methods such as AHP. Avoid the suspicion of the objective analysis method such as principal component analysis and entropy method, and it is more systematically express the impact of various indicators on the ecological security of the land.

(1) Calculation of the initial matrix

After normalizing the index data of each year, the matrix A′ is obtained, and the maximum value in the index y_j is proposed to form an optimal column vector, that is, the decision matrix $B=(y_{01},y_{02},\ldots y_{0j})$Then, according to the formula $y_{0j}-y_{ij}$, each factor in the matrix A is transformed to obtain an initial matrix $A'=(y_{01}-y_{i1},y_{02}-y_{i2},\ldots y_{0j}-y_{ij})$.

(2) Grey correlation calculation

The gray correlation degree is calculated according to formula 3 for each factor in the initial matrix A, and the multi-objective gray correlation degree judgment matrix $r=(r_{i1},r_{i2}\ldots r_{ij})$ is obtained.

$$r_{ji}=\frac{\min\min(y_{0j}-y_{ij})+\rho\max\max(y_{0j}-y_{ij})}{(y_{0j}-y_{ij})+\rho\max\max(y_{0j}-y_{ij})} \tag{3}$$

In the formula, the resolution coefficient is usually 0.5.

(3) Weight calculation

According to the grey relational theory, the correlation degree rij actually represents the degree of correlation between the actual value of the jth indicator of the i-th year and its ideal value, so the average value of the i-th year of the j-th index can be very good. Reflect the proportion of the j-th indicator in the overall evaluation system, namely:

$$\overline{\omega}_j=\frac{1}{10}\sum_{i=1}^{10}r_{ij} \quad (j=1,2,...25) \tag{4}$$

At the same time, in order to make the index weight more in line with the actual situation, the sum of their weights is always 1, and the weight of each indicator is normalized:

$$w_j=\frac{\overline{\omega}_j}{\sum_{j=1}^{25}\overline{\omega}_j} \tag{5}$$

For the Chengdu City from 2006 to 2015, the weight of the land ecological security evaluation index is calculated according to the method shown in Table 1.

3.3 Calculation of Chengdu Land Ecological Safety Comprehensive Evaluation Index

By summing the safety index of each indicator and its weight product to obtain the land ecological security score of a certain year, the ecological security status and changes of the land over the years can be analyzed through numerical comparison, namely:

$$D_i=\sum_{j=1}^{25}w_j s_{ij} \quad (i=1,2,...10) \tag{6}$$

In Equation 6, Di is the i-year land ecological security comprehensive index, s_{ij} is the safety index of the single indicator, and w_j is the weight of the j-th indicator.

4. Data Analysis

4.1 Data Processing Results

According to the calculated scores of various indicators, based on the research results of previous researchers [13-14], based on the socio-economic status of Chengdu, the state of resources and environment, the comprehensive value of land ecological security is divided by non-equal spacing method (0 -1) is five levels, as shown in Table 3.

Table 3 Division of Land Ecological Security Level in Chengdu

Ecological safety value	Level	Characterization state	System characteristics
(0,0.4]	I	Bad grade	The fragile ecological environment of the land has been seriously damaged, the system structure is incomplete and the service function is lost. Ecological restoration and reconstruction are difficult, and ecological problems are rooted and often evolve into ecological disasters.
(0.4,0.6]	II	Risk level	The ecological environment of the land has been greatly damaged, the system structure has deteriorated severely, the service function has been seriously degraded, and it has been difficult to recover from external disturbances. The ecological problems are large and natural disasters are prone to occur.
(0.6,0.7]	III	Sensitive level	The land ecological environment is poor, the system structure is damaged to a certain extent, and the service function is degraded but the basic functions can still be maintained. When there is ecological destruction, there are life problems, and ecological problems are significant.
(0.7,0.9]	IV	Good grade	The ecological environment of the land is relatively good, the system structure is complete, less damaged, and the service function is relatively complete. The ecological damage is unlikely, and the ecological problem is not significant.
(0.9,1]	V	Security level	The land has a good ecological environment, basically no damage, complete system structure and perfect service functions. Ecological killing roots occur less, and ecological problems are not significant

Based on the weights obtained by the DPSIR model and the grey correlation method (Table 1) and the normalized values of the indicators, the comprehensive scores of the land ecological security and the scores of each layer of the Chengdu City from 2006 to 2015 are calculated according to Equation 6. See Table 4 for details.

Table 4 Comprehensive Evaluation of Land Ecological Security in Chengdu from 2006 to 2015

Year	Driving force	Pressure index	State index	Impact index	Response index	Comprehensive index	Safety level
2006	0.1817	0.1715	0.1332	0.1378	0.0803	0.7045	Sensitive level
2007	0.1858	0.1709	0.1317	0.1380	0.0910	0.7174	Good
2008	0.1896	0.1929	0.1358	0.1343	0.0940	0.7467	Good
2009	0.1910	0.1933	0.1348	0.1195	0.0984	0.7371	Good
2010	0.1905	0.1936	0.1441	0.1178	0.0990	0.7449	Good
2011	0.1895	0.1945	0.1409	0.1169	0.0924	0.7343	Good
2012	0.1882	0.1977	0.1409	0.1151	0.0968	0.7387	Good
2013	0.1880	0.1983	0.1428	0.1123	0.0993	0.7407	Good
2014	0.1884	0.1968	0.1424	0.1105	0.1008	0.7389	Good
2015	0.1888	0.1962	0.1371	0.1089	0.1022	0.7330	Good

4.2 Analysis of data results

According to the results of the evaluation of land ecological security in Chengdu from 2006 to 2015, the comprehensive index of land ecological security is between 0.7045 and 0.746. Except that the safety level in 2006 is sensitive, the safety level of the remaining years in the evaluation period is good. It can be seen that in the decade of 2006-2015, Chengdu's land ecological environment is good, the system structure is relatively complete, the service function is relatively perfect, and the land ecological problems are not significant. Among them, Chengdu's land ecological status is the best in 2008. Although Chengdu's land ecological comprehensive index is in a good level, it has a small difference from the next level of sensitive level, and the maximum difference is only 0.449, indicating that if the land is unreasonably used, Chengdu's land ecological security will be being threatened.

4.2.1 Analysis of Chengdu's Land Ecological Security Comprehensive Index

Overall, the comprehensive index of land ecological security in Chengdu increased from 0.7045 in 2006 to 0.7330 in 2015, an increase of 0.0285, and the level of land ecological security increased from sensitive to good, indicating that the overall situation of Chengdu's land ecological security level was obtained. Must improve. Specifically, the Chengdu Land Ecological Security Composite Index increased year by year in 2006-2008, with a growth rate of 5.99%. In 2008, it reached a maximum of 0.7467 in the past decade. In 2008-2015, it reached 0.7449 in 2010 and 2013. And 0.7407, but the maximum peak value in 2008 also showed a downward trend, the decline reached 1.83%, as shown in Figure 2.

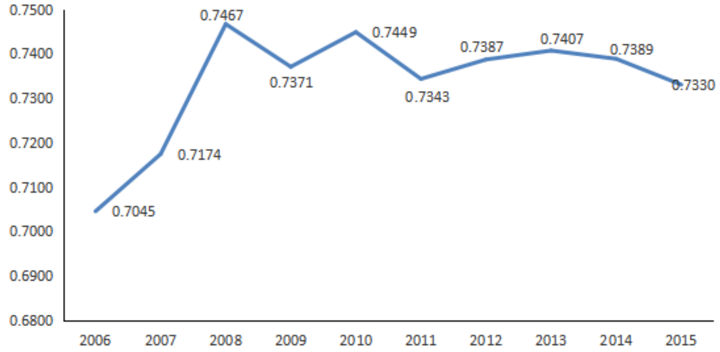

Fig.2 Trends in Chengdu's 2006-2015 Land Ecological Security Composite Index

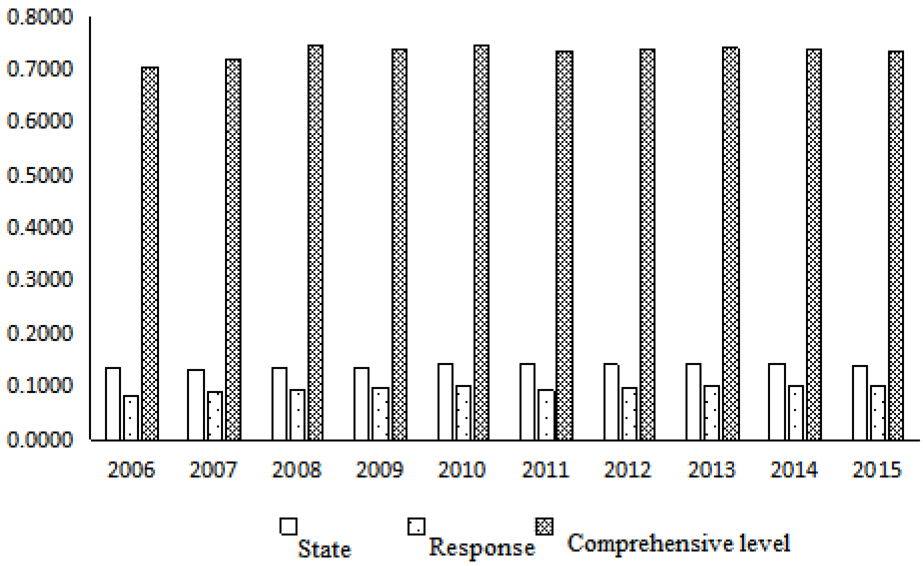

Fig.3 Chengdu Urban Ecological Integrated Safety Index and Status and Response Safety Index

Through the comparison with the driving force, pressure, state, influence and response index trends, the state index and response index increased during 2006-2008, which led to the increase of the land ecological security composite index; the decline and response of the state index during 2008-2009 The increase in the index led to a decline in the comprehensive index of land ecological security. During the period of 2009-2010, the increase in the state index and the response index led to an increase in the comprehensive index of land ecological security. During 2010-2012, the decline in the state index and response index caused the decline in the comprehensive index of land ecological security. In 2012-2013, the rise of the state index and the response index led to an increase in the land ecological safety composite index; during 2013-2015, the decline in the state index and the response index led to an increase in the land ecological safety composite index, as shown in Figure 3. It can be seen that the status of land and the response of society to the protection of land ecological security are the main factors affecting the comprehensive index of land ecological security in Chengdu, and the impact of land ecological status is greater.

4.2.2 Analysis of the Index of Land Ecological Safety Guidelines in Chengdu

The Chengdu Land Ecological Driving Safety Index showed an overall growth trend, increasing from 0.1817 in 2006 to 0.1888 in 2015, an increase of 3.91%. Mainly due to the continuous reduction of the energy consumption of Chengdu's 10,000 yuan GDP to 47.60%, which is far below the policy requirement, and the per capita GDP continues to grow to be much higher than the national average of 74,237 yuan/person, making the land ecological driving force indicator A growth trend.

The Chengdu Land Ecological Pressure Safety Index showed an overall growth trend with an increase of 14.40%. The main reason is the continuous reduction of the use of pesticides and chemical fertilizers in agricultural production, as well as the reduction of control of wastewater and exhaust emissions in industrial production, which has contributed to the substantial increase in the safety indicators of land ecological pressure in Chengdu.

The land ecological status safety index of Chengdu has fluctuated up and down, reaching a maximum of 0.1441 in 2010, which is closely related to the fluctuation of per capita arable land area and unit land sewage carrying capacity.

The land ecological impact safety index of Chengdu showed a downward trend. The land ecological environment has an impact on human production and life, mainly reflected in the reduction of grain production per unit of cultivated land from 511.38 kg/mu in 2006 to 362.87 kg/mu in 2015, and The proportion of farmers' agricultural income decreased from 50.84% in 2006 to 17.60% in 2015.

Chengdu's land ecological response safety index showed an overall growth trend, increasing from 0.0803 in 2006 to 0.1022 in 2015. The main reason is that the society and the government pay more attention to ecological security issues, increase the control of pollution and the investment in protection, increase the comprehensive utilization rate of industrial solid waste to 98.15%, and increase the discharge rate of industrial wastewater to 91.22%.

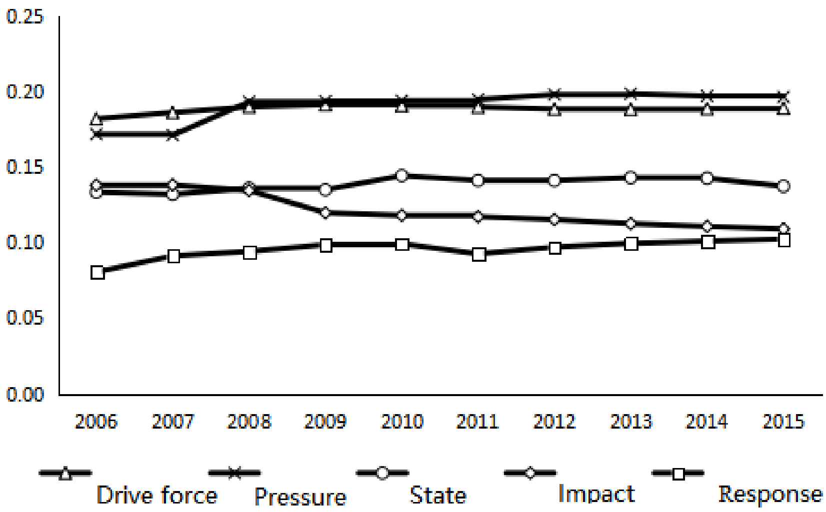

Fig.4 Chengdu Land Ecological Safety Standards Index Index

5. Conclusion

Based on the DPSIR model, this paper establishes a land ecological security evaluation system that conforms to Chengdu's land resources, social economy and environmental status, adopts the grey correlation method to obtain the weights of various indicators, and uses the comprehensive index method to develop the land ecological security of Chengdu from 2006 to 2015. The index was calculated and the following conclusions were obtained:

(1) The ecological security status of Chengdu's land has been improved. In 2006-2015, the Chengdu Land Ecological Comprehensive Index increased from 0.7045 in 2006 to 0.7330 in 2015, an increase of 0.0285. The safety level increased from sensitive to good, and the overall status of the land ecological security level was improved.

(2) Land ecological security is under pressure. Although the comprehensive index of land ecological security in Chengdu shows an upward trend, the comprehensive index of land ecological security in a good grade is close to the critical value of this level and sensitivity level, and there is still tremendous pressure on the protection of land ecological security.

(3) The ecological security of the land has been paid attention to, but the degree of influence on people's production and life has increased. From the perspective of the index index index, the driving force, pressure, and response safety index show a general growth trend. The land ecological security problem status safety index fluctuates up and down. People put the land ecological security status from the aspects of economy, production, population and environmental protection. Pay attention to improving the ecological status of Chengdu's land by adopting certain policies and economic means. The land ecological impact safety index shows a downward trend, indicating that the impact of Chengdu's land ecological security issues on people's living production is intensifying and should be paid attention to by the society.

(4) The land ecological status and response safety index are the main influencing factors of the comprehensive index. Through the comparison of the driving force, pressure, state, impact and response index trends and the comprehensive index, it is found that the improvement of the state of land production service and the increase of the society's response to the land ecological environment protection can effectively improve the comprehensive index of land ecological security. Improve the ecological status of the land.

References

[1] Wang Peng, et al. Evaluation of Land Ecological Security in Hengyang City Based on Principal Component Analysis [J]. Economic Geography, 2015(1): 168-172.

[2] Zhang Li, Chen Ying, Wang Shutao et al. Evaluation and early warning of land ecological security in coastal rapid urbanization areas: taking Caofeidian new area as an example[J]. Chinese Journal of Applied Ecology, 20215, 26(8): 2445-2454.

[3] Zhao Zhigang, Wang Kairong, Xie Xiaoli.Ecological Safety Assessment of Agricultural Sustainable Development in Jiangxi Province[J].Journal of Ecology and Rural Environment,2012,28(3):225-230.

[4] Wu Cifang, Bao Haijun. Theory and Method of Land Resource Security Research [M]. Beijing: Meteorological Press, 2004: 120-135.

[5] Liu Yanfang, Ming Licai, Kong Xuesong. Land Ecological Security Assessment Based on PSR Model and Matter Element Model——Taking Daye City, Hubei Province as an Example[J].Jiangsu Agricultural Sciences,2017,45(05):271 -277.

[6] Guo Yulun, Shi Xueyi, Qi Lulu, Liu Chang. Evaluation of Urban Land Ecological Security Based on PSR-CPM Model [J]. Soil and Water Conservation Research, 2017, 24(04): 108-112.

[7] Zhang Ru, Dai Wenting, Liu Zhaoshun, Dong Yihong. Evaluation of Land Ecological Security in the Agro-pastoral Ecotone in Northern China——Taking Baicheng as an Example [J].Research

of Soil and Water Conservation,2017,24(02):259-266.

[8] Xu Mei, Zhu Xiang, Li Jingzhi. Evaluation of Land Ecological Security in Hunan Province Based on DPSIR-TOPSIS Model[J].Journal of Glaciology and Geocryology,2012,34(5):1265-1272.

[9] Li Jianchun, Yuan Wenhua.Study on Land Ecological Security Evaluation of Yinchuan City Based on GIS Grid Model[J].Journal of Natural Resources,2017,32(06):988-1001.

[10] Carr E R, Wingard P M, Yorty S C, et al. Apply DPSIR to sustainable development [J]. International Journal of Sustainable Development & World Ecology, 2007, 14(6): 543-555.

[11] Zheng Qiyang, Wang Chunbin, Jiang Lishao, Lu Fanfeng. Land Ecological Security Evaluation Based on DPSIR Modified Model——Taking Zhoushan City as an Example[J].Hubei Agricultural Sciences,2016,55(16):4158-4164.

[12] GUO Yulun, SHI Xueyi, YAN Lulu, LIU Chang. Evaluation of Urban Land Ecological Security Based on PSR-CPM Model [J]. Soil and Water Conservation Research, 2017, 24(04): 108-112.

[13] Lu Lifeng, Yan Lijun. Evaluation of County Land Ecological Security——Taking Danling County of Sichuan Province as an Example [J].Journal of Ecology and Rural Environment, 2013, 29(03):295-300.

[14] Zhang Bo, Han Linlin, Han Fei. Land Ecological Security Assessment Based on DPSIR Model——Based on Panel Data of 18 Provinces along the Belt and Road Initiative [J].World Agriculture,2017,(08):101-105.