



Research on the Technological Progress, Development of Regional Economic and Ecological Environment Quality of Guizhou Province

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Abstract: Taking Guizhou Province as an example, we analyzed the status of eco-environmental quality in Guizhou Province under the technical progress and development of regional economic by constructing the model of ecological environment quality. Through the analysis, we concluded that the ecological environment of Guizhou province is "good", and the quality of the ecological environment is stable. At the same time, compared with 2010, the biological abundance index of Guizhou province increased by 1.5 in 2015, it shows that the ecological system has been improved gradually in 2015, and the system function is optimized; The vegetation cover index of Guizhou province increased by 1.06 in 2015, and the development trend of surface vegetation in Guizhou province was better in general; Water density index of Guizhou province in 2015 increased by 2.21. The main factor of the change of water density index is the expansion of rivers and lakes; The land degradation index in Guizhou province increased by 0.62 in 2015. The land degradation index is lower compared with the other regions of the country, the main reason lies in that the larger proportion in moderate and severe erosion of the total area of land area; The environmental quality index of Guizhou province increased by 4.04 in 2015. The main factor is the relative amount of environmental pollutant emissions decreased year by year.

Keywords: technological progress, ecological environment quality, regional economic, comprehensive calculation

1. Introduction

Technological progress has played a huge role in promoting economic growth, and technological progress has improved the efficiency of resource allocation, so that making the same number of inputs more productive than before. With the continuous expansion of the scale of the economy, as the progress of technological promoting the rapid growth of the economy, it has consumed huge nonrenewable resources, and polluted the environment of human being's existence, and also made the ecological environment become more and more serious. The development of technological progress is facing the dual pressures of promoting economic growth and development as well as reducing the pollution of the environment. Therefore, economic growth as the fundamental source of technological progress must be sustainable. Development of regional economic should be based on structural optimization, quality improvement, efficiency increase and consumption reduction, in the process of regional economic development; we should make mandatory environmental indicators to control the economic extensive growth, so as to realize the unity of the regional economic and environmental benefits.

Environmental quality assessment in abroad began from the mid-1960s, and environmental quality assessment has been booming in 1970s. In 1980s,

with the development and popularization of computer, a number of advanced technology to display skills to the full in the field of Environmental Science especially on the "3S" technology as the representative of the research means. At the end of the 20th century, foreign environment quality evaluation has made rapid development in the research technique and research means, and made a special treatment on the evaluation results, so that the method of ecological environment evaluation has been improved. Among them, the quality of urban ecological environment was very extrusive. The environmental quality assessment has carried on from the beginning of 1970s in China, and the content of the evaluation is mainly based on current situation of urban environmental pollution where the population is concentrated relatively. After 1980s, it began to turn into the impact assessment of engineering projects. Until the end of the 80s to the beginning of 90s, people began to pay more attention to the quality evaluation of ecological environment gradually. With the rapid development and wide application of RS and GIS technologies, and the continuous improvement of acquisition, processing and analysis technology of spatial information data, they have been paid more attention in the investigation, monitoring, evaluation and other aspects.

In recent years, the ecological environment in the western region is still getting worse and worse. A

large number of phenomena of forest reduction, severe desertification of land (rock), increased land erosion, frequent natural disasters can be seen everywhere, some of them even threaten the basic survival of human beings. In this case, the pressure of resources and environmental is enormous, economic development has not yet embarked on the track of innovation driven and endogenous growth. Regional economic growth will cause serious environmental pollution inevitably, which will restrict the optimization of regional economic structure and the improvement of production efficiency. Therefore, whether the regional economy and ecological environment system developed coordinately and how to make it develop coordinately is a major issue which is related to the regional sustainable development. So this research has important practical significance.

With the development of the western region, the rapid economic development of Guizhou province, great changes have happened in people's living standards. So is Guizhou Province has produced a decline in environmental quality in the development of the western region? Therefore, it is urgent and important to make a scientific evaluation of the ecological environment quality in Guizhou province. Taking Guizhou Province as an example, we analyzed the status of eco-environmental quality in Guizhou Province under the technical progress and development of regional economic by constructing the model of ecological environment quality in order to provide the basis for the relevant departments to make decisions.

2. Model of ecological environment quality index of Guizhou Province

2.1. Introduction of the model

Based on the theory of landscape ecology and the environment discipline, the model established five indicators of biological abundance index, vegetation cover index, water density index, land degradation index and environmental quality index as the main factor of the assessment of the quality of environmental evaluation with the aid of remote sensing and GIS technology and by using the monitoring data of environmental protection fully. Specification also provides: (1) the weight of the first level index and the second level index of the five indicators; (2) specific calculation method of the five indicators and calculation method of the comprehensive environmental quality index; (3) classification and grading standard of the conditions of ecological environmental quality and changing degree of ecological environment quality.

We can modify the weight of the first level index and the second level index according to the actual demand when using this specification to evaluate the specific regional ecological environmental quality. At the same time, nine normalization coefficients can be received by the subordinate units of the evaluation

units in order to reflect regional ecological environment situation more accurately, and the advantage is that we can study area ecological environment quality index more accurately.

2.2. Determination of evaluation criteria

In this study, in order to facilitate the comparison in Guizhou province, we used the evaluation standard of ecological environment quality which specified in technical specification for evaluation of ecological environmental conditions (for Trial Implementation) (HJ/T192—2006).

According to the comprehensive evaluation index of the ecological environment, the ecological environment is divided into five grades including excellent, good, general, poor, worse, and a qualitative description of the score and the state characteristics of each grade (as it is shown in Table 1).

Table 1: Classification of assessment standards of ecological environmental quality

Level	Index standard	State characteristics
Excellent	$EQI \geq 75$	Good vegetation coverage and biodiversity, ecosystem stability, the most suitable for human survival
Good	$55 \leq EQI < 75$	The vegetation coverage is high, and the biodiversity is rich, it is suitable for human survival basically
General	$35 \leq EQI < 55$	Vegetation coverage is middle and biological diversity is general, more suitable for human survival, but there is not suitable for human survival constraints appear
Poor	$20 \leq EQI < 35$	Poor vegetation coverage, severe drought and little rain, fewer species, there are obvious factors restricting the survival of human beings
Worse	$EQI < 20$	The condition is bad, and the human living environment is bad.

According to the change of ecological environment quality index, we grade the change of ecological environment quality index in different period (as it is shown in Table 2).

Table 2: Gradation of change degree of ecological environment status

Dynamic level	Various value	State characteristics
No obvious change	$ \Delta EI \leq 2$	There was no obvious change in the ecological environment

Slight change	$2 < \Delta EI \leq 5$	If $2 < \Delta EI \leq 5$, the ecological environment is slightly better; If $-2 > \Delta EI \geq -5$, the ecological environment is slightly changed.
Obvious change	$5 < \Delta EI \leq 10$	If $5 < \Delta EI \leq 10$, the ecological environment is obviously better; If $-5 > \Delta EI \geq -10$, the ecological environment is obviously worse.
Significant change	$ \Delta EI > 10$	If $\Delta EI > 10$, the ecological environment status is significantly better; If $\Delta EI < -10$, the ecological environment status is obviously worse.

2.3. Determination of index weight and calculation method

2.3.1. Weight of the first level index

In this research, the first level index includes five aspects which are biological abundance index (BAI), vegetation cover index (VCI), water density index (WDI), land degradation index (LDI) and environmental quality index (EQI), the weight of each index is shown in table 3.

Table 3: Weight of the First level index

Index	BAI	VCI	WDI	LDI	EQI
Weight	0.3	0.25	0.2	0.15	0.1

The calculation formula of the ecological environmental quality index (EI) is as follows:

$$EI = 0.3 \times \text{Biological abundance index} + 0.25 \times \text{Vegetation cover index} + 0.2 \times \text{Water density index} + 0.15 \times \text{Land degradation index} + 0.1 \times \text{Environmental quality index}$$

2.3.2. Weight of the second level index

(1) Calculation of biological abundance index

$$\text{Biological abundance index} = Abio \times (0.35 \times \text{Woodland (WL)} + 0.25 \times \text{Grassland (GL)} + 0.25 \times \text{Water wetland (WW)} + 0.1 \times \text{Arable land (AL)} + 0.04 \times \text{Building-land (BL)} + 0.01 \times \text{Unused land (UL)}) / \text{Area}$$

Among them, Abio represents the normalized coefficient of biological abundance index. The area unit of the two level indexes is km².

Table 4: Second level index of biological abundance index and their weight

Second Index	WL	GL	WW	AL	BL	UL
Second Weight	0.35	0.25	0.25	0.1	0.04	0.01

(2) Calculation of Vegetation cover index

$$\text{Vegetation cover index} = Aveg \times (0.4 \times \text{Area of woodland} + 0.35 \times \text{Area of grassland} + 0.2 \times \text{Area of arable land} + 0.04 \times \text{Area of building land} + 0.01 \times \text{unused land}) / \text{Area}$$

Among them, Aveg represents the normalized coefficient of vegetation cover index

Table 5: Third level index of vegetation cover index and their weight

Second Index	WL	GL	AL	BL	UL
Second Weight	0.4	0.35	0.2	0.04	0.01

(3) Calculation of land degradation index

$$\text{Land degradation index} = Aero \times (0.05 \times \text{Slight erosion area} + 0.25 \times \text{Moderate erosion area} + 0.7 \times \text{Severe erosion area}) / \text{Area}$$

Among them, Aero represents the normalized coefficient of land degradation index

(4) Calculation of Water density index

$$\text{Water density index} = Ariv \times \text{River length} / \text{Area} + Alak \times \text{Lake (Offshore) area} / \text{Area} + Ares \times \text{Water resources quantity} / \text{Area}$$

Among them, Ariv represents normalized coefficient of river length.

Alak represents normalized coefficient of lake area.

Ares represents normalized coefficient of water resources quantity.

Table 6: Classification criterion of land erosion intensity

Level	Slight erosion	Moderate erosion	Severe erosion
Average erosion modulus	≤ 2500	2500-5000	≥ 5000
Average loss thickness	≤ 1.9	1.9-3.7	≥ 3.7

(5) Calculation of Environmental quality index

$$\text{Environmental quality index} = 0.4 \times (100 - \text{ASO}_2 \times \text{SO}_2 \text{ Emission} / \text{Area}) + 0.4 \times (100 - \text{ACOD} \times \text{COD Emission} / \text{Regional average annual rainfall}) + 0.2 \times (100 - \text{Asol} \times \text{output of solid wastes} / \text{Area})$$

Among them, ASO₂ represents normalized coefficient of SO₂

ACOD represents normalized coefficient of COD.

Asol represents normalized coefficient of solid waste.

3. The measure of ecological environmental quality index of Guizhou Province

3.1. Data processing

- (1) Considering ARCGIS as a platform, we establish the database of land use/cover change, land erosion, water distribution and so on , and generating the data file (*.cov.).
- (2) Using the function of query, display and graphics output of ARCGIS to obtain the map of land use classification, land erosion, water distribution and other distribution of Guizhou Province.
- (3) Queried by attributes in ARCGIS at the first, and then made statistics in the EXCEL, and calculated the number of area, proportion and patch as the basic data for the calculation of the ecological environment quality index.
- (4) To calculate the biological abundance index, vegetation cover index, water density index land degradation index, environmental quality index and normalized coefficient of Guizhou Province according to the standard. To obtain the index value of ecological environment quality of Guizhou province according to the calculation method of composite index.
- (5) To determine the level of the ecological environment of Guizhou Province according to the division level of ecological environment quality index.
- (6) To determine the level of the ecological environment change of Guizhou Province according to the division level of ecological environment quality index change.

3.2. Comprehensive calculation of ecological environment quality index

On the basis of the basic data processing, according to the calculation method of the ecological environment quality index, data synthesis is carried out by five indexes, we can obtained the specific calculation results which is shown in table 7 and table 8.

Table 7: Evaluation results of the ecological environmental quality index of Guizhou Province

Year	Biological abundance index	Vegetation cover index	Water density index	Land degradation index	Environmental quality index
2010	44.75	44.86	60.37	35.92	62.38
2015	46.25	45.92	62.58	36.54	66.42

From the analysis above, in Guizhou Province, the highest biological abundance index was Wanshan district, and the lowest was the Liupanshui city, the highest vegetation cover index was Tianzhu County and the lowest was Liupanshui, the highest water density index was Pingba County and the lowest was Bijie City, the lowest land degradation index was Chishui City, Rongjiang County, Jinping County, Jianhe County, Leishan County, Liping County, Sansui County, Congjiang County, Shuicheng County etc, the highest was Changshun County, the highest environmental quality index is Tianzhu County and the lowest was Liupanshui city.

Table 8: Comprehensive and dynamic of evaluation results of ecological environment quality index of Guizhou Province

Year	Eco-environmental quality index EI	the level of Eco-environmental quality index	Ecoenvironmental quality index ΔEI	Change level
2010	58.72	Good		No
2015	62.56	Good	0.49	obvious change

Overall, the province's ecological environment assessment is "good", the quality of the ecological environment maintain stability. The highest eco-environmental status index is Qiandongnan district which is 72.89 among the nice Cities (states).The assessment results of eco-environmental quality are "good" and "general" from County, among them, the level of "good" has 64 counties, accounting for 72.73% of the total, and the level of "general" has 24 counties, accounting for 27.27% of the total. From the distribution of regional spatial, the "good" level of the county is mainly distributed in the eastern, the southern and the northern regions of Guizhou province.

The composite index calculation result shows that the assessment result of province's ecological environment is "good", the quality of the ecological environment maintain stability. The eco-environmental quality index improved from 2010 which is 58.72 to 2015 which is 62.56. The ecological environment quality index of the two periods is $55 < EI < 75$, the level of the ecological environment quality is good. The change value of ecological environment quality index is 0.49, and the change level of $|\Delta EI| \leq 2$ is not change significantly.

3.3. Analysis of ecological environmental quality index

From the analysis result above, there was a marked change in each sub index between 2010 and 2015 while the comprehensive index of ecological environment changes in Guizhou Province(as it is shown in figure1).

(1) Biological abundance index

Biological abundance index reflects the evaluation of degree of abundance of biological abundance in the area of poverty according to the differences in the number of species of different type of ecological system indirectly. And the calculation results shows that the biological abundance index was 44.75 in 2010 in Guizhou Province, and it increased to 46.25 in 2015, that is the biological abundance index was 1.5 higher than in 2010 which represents the ecological system has been improved gradually, and the system function has been optimized in 2015.

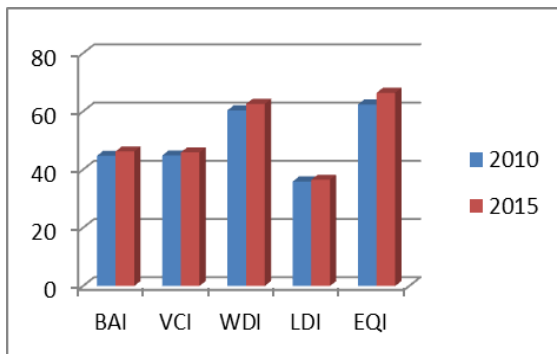


Figure 1: Change of ecological environment quality of Guizhou Province during 2010-2015

(2) Vegetation cover index

Vegetation cover index reflects the cover degree of regional vegetation which is evaluated through evaluate the proportion of the area of woodland, grassland, farmland, construction land and unused land to the regional area in the evaluation area. Vegetation coverage is the basic parameters of reflecting the ecological system, and it reflects the impact of human activities on the surface coverage status. The calculation results shows that the vegetation cover index was 44.86 in 2010 in Guizhou Province, and it increased to 45.92 in 2015, that is the vegetation cover index was 1.06 higher than in 2010, the development trend of surface vegetation in Guizhou province is better in general.

(3) Water density index

It refers to reflect the proportion of the total length of river, water area and quantity of water resource to the regional area, used to water abundance assessment area. And the calculation results shows that the water density index was 60.37 in 2010 in Guizhou Province, and it increased to 62.58 in 2015, that is the water density index was 2.21 higher than in 2010. The main factor of the change of water density index is the expansion of rivers and lakes.

(4) Land degradation index

Land degradation index refers to reflect the proportion of wind erosion, water erosion, gravitational erosion, freeze-thaw erosion and the erosion of the engineering area to the is accounted for by evaluation of the proportion of regional area, and it is used to reflect the degree of land degradation. The calculation results shows that the land degradation index was 35.92 in 2010 in Guizhou Province, and it increased to 36.54 in 2015, that is the land degradation index was 0.62 higher than in 2010. The land degradation index is lower compared with the other regions of the country, and the main reason lies in that the larger proportion in moderate and severe erosion of the total area of land area.

(5) Environmental quality index

The calculation results shows that the environmental quality index was 62.38 in 2010 in Guizhou Province, and it increased to 66.42 in 2015, that is the environmental quality index was 4.04 higher than in 2010. The main factor is the relative amount of environmental pollutant emissions decreased year by year.

4. Conclusion

In recent years, the economy of Guizhou province has achieved rapid development, and great changes have happened in people's living standards, and the quality of ecological environment in Guizhou province has aroused concern, so we analyze the status of ecological environment quality in Guizhou Province in the rapid development of technical progress and regional economic through the construction of ecological environment quality model. Through the analysis, we concluded that the ecological environment of the province is "good", and the quality of the ecological environment is stable. At the same time, compared with 2010, the biological abundance index of Guizhou province increased by 1.5 in 2015, it shows that the ecological system has been improved gradually in 2015, and the system function is optimized; The vegetation cover index of Guizhou province increased by 1.06 in 2015, and the development trend of surface vegetation in Guizhou province was better in general; Water density index of Guizhou province in 2015 increased by 2.21. The main factor of the change of water density index is the expansion of rivers and lakes; The land degradation index in Guizhou province increased by 0.62 in 2015. The land degradation index is lower compared with the other regions of the country, the main reason lies in that the larger proportion in moderate and severe erosion of the total area of land area; The environmental quality index of Guizhou province increased by 4.04 in 2015. The main factor is the relative amount of environmental pollutant emissions decreased year by year.

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