Construction and Empirical Research on Measurement Index System of Low-carbon City in Guizhou Province

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Abstract: Global climate change caused by carbon dioxide and other greenhouse gas emissions has become increasingly concerned by the international community.Based on carbon source and carbon sink analysis frame in low-carbon economy theory, this paper constructs a low-carbon city measure index system which includes thirteen indexes, which are production, transportation, construction and living carbon sources, forest and green land carbon sink.

Introduction

Current our country city's greenhouse gas emissions rank first in the world [1,2], the problem of urban low-carbon need to be resolved. Under the background of global climate change, low-carbon city has become inevitable choice for sustainable development of city in the future. Through this study, on the one hand, we can provide a universal index system for evaluating low-carbon city. On the other hand, through the empirical analysis, we find out the characteristics and differences between different low-carbon cities, put forward countermeasures and suggestions to speed up the construction of low-carbon city, achieve the goal of " evaluation promotes construction".

S. T. Shwayri (2013) believed that per capita carbon emissions should be used instead of total carbon emissions to measure the level of low-carbon city [3]. Dai Yixin (2009), Tsinghua University, believed that the development level of low-carbon cities can be seen from intensity of carbon emissions [4].The other is using comprehensive index systems. S. Rory et al. (2013) from the target of ecological environment protection, according to the world bank data in 2010[5]. Lian Yuming (2012) considered low-carbon city is one kind of urban form in the era of ecological civilization[6].

Low-carbon City Measurement Index System Construction

Index System Design Idea

In low-carbon economy theory, the activities that release carbon dioxide into atmosphere are called "carbon source", the activities that remove carbon dioxide out from atmosphere are defined as "carbon sink". The significance of carbon source and carbon source analysis framework is, for the first time, "carbon" as a bridge between man and nature, establish a balance mechanism of carbon release and absorption. It explores carbon emissions and carbon uptake in a space range of human production and living in the city. Therefore, to measure the development level of low-carbon city, the dynamic mechanism of carbon source and carbon sink are carried out.

Establishment of Index System

According to design idea and selection principle of index system, this paper determined low-carbon city measure index system, as shown in Table 1.

Table 1 Measurement Index System of Low-carbon Cities

target layer	Standard layer	factor layer	index layer	Unit	Positive and negative
Low carbon city index	carbon source	Production carbon source	Energy intensity（X_1）	Tons of standard coal / million	—
			Carbon emission intensity（X_2）	Tons / million	—
			Carbon emissions per unit of industrial GDP（X_3）	Tons / million	—
			Sulfur dioxide emissions per unit of industrial GDP（X_4）	Tons / million	—
		Transportation carbon source	Private cars per one hundred people（X_5）	Vehicle / one hundred	—
			proportion of non-clean energy vehicles（X_6）	%	—
			transportation carbon emissions per capita（X_7）	Tons/ person	—
		construction and residents living carbon source	proportion of non-green building（X_8）	%	—
			Residents per capita electricity consumption（X_9）	KWh / person	—
	Carbon sink	Forest Carbon sink	Planting area per hundred people（X_{10}）	Square meters / person	+
			Forest coverage（X_{11}）	%	+
		Greenland Carbon sink	Proportion of green area accounted for the total area of the city（X_{12}）	%	+
			Per capita green area（X_{13}）	Square meters / person	+

An Empirical Analysis of Low-carbon City Measurement of 9 Prefecture-level Cities in Guizhou Province

Data Collection and Standardization

The original data come from “China Statistical Yearbook”, “China Urban Statistical Yearbook”, “China Environmental Statistics Yearbook”, “Guizhou Statistical Yearbook” , “Guiyang Statistical Yearbook ” and local statistical yearbook of other provinces and cities in 2014 year.

Index Weight Calculation Formula

Set U_{ij} as the index value of line i column j, m is the number of rows, K is the number of columns, f_j and p_j respectively is weight value and entropy of standardized data in column J. A expresses index value is positive or negative sign. Then

$$f_j = \frac{1 - p_j}{\sum_{j=1}^{k}(1 - p_j)} \quad (1)$$

$$p_j = A \cdot k \sum_{i=1}^{m}\left[\left(u_{ij} \Big/ \sum_{i=1}^{m} u_{ij}\right) \cdot \ln\left(u_{ij} \Big/ \sum_{i=1}^{m} u_{ij}\right)\right] \quad (2)$$

Equality (1) and equality (2) are calculation formulas of index weight.

Measurement Results and Analysis

Standardization value is substituted in weighted average formula (Equation 3). When g=1 and h=13, low-carbon city index of 9 pilot cities can be obtained, as shown in table 2.

$$\text{Assessment results} = \sum_{j=g}^{h}\left(f_{ij} \cdot u_{ij}\right) i=1,2,\ldots,9 \quad (3)$$

When g=1 and h=4, g=5 and h=7, g=8 and h=9, g=10 and h=11, g=12 and h=13, we can obtain production carbon source，transportation carbon source, construction and residents living carbon source, forest carbon sink, Greenland carbon sink of 9 cities.

Policy Suggestions

Clustering analysis was carried out on low-carbon city, which is helpful for government decision-making departments making targeted policies and measures for each category of cities to better promote the process of urban low-carbon.

First of all, for Anshun, Zunyi, etc, effectiveness is outstanding in reducing production carbon source. Because production low-carbon level is already quite high, in the future, we can focus on mining potential of saving energy and reducing emission from transportation carbon source, construction and residents living carbon source.

Secondly, low carbonization of Guiyang and Qiandongnan should focus on the transportation sector. By developing subway, light rail, intercity express train and other public transport network promote new energy vehicles, and using other measures reduce transportation carbon emissions.

Then, For Southwest Guizhou and South Guizhou, which construction and residents living carbon source is more prominent, there are two ways to promote their low-carbon development. On the one hand, promote green building standards and energy saving building materials; on the other hand, strengthen propaganda low-carbon life concept, encourage residents consciously practice low-carbon lifestyle.

For Bijie, Tongren and other carbon sinks rich cities, we should try our best to protect forest and green resources. At the same time, take appropriate measures to reduce all kinds of carbon sources, try to keep the good situation that carbon sink is greater than carbon source.

At last, for Liupanshui with low-ranking, strategic planning of low-carbon city development should be made. Low-carbon planning of three major carbon sources: production, transportation, construction and residents living are incorporated into the overall urban planning, develop low-carbon industry structure system, improve energy utilization efficiency, push green transportation, promote urban construction to low carbon transition, lead residents to low carbon consumption, strongly advocated afforestation and roof greening, speed up urban low-carbon development.

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