Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

p-ISSN: 0972-6268
e-ISSN: 2395-3454

Vol. 18 | No. 2 | pp. 569-577 | 2019

Original Research Paper | **Open Access**

Towards a Theory of Decoupling: The Relationship of Carbon Emission and Construction Land Expansion Between 1997 and 2012 in Hefei City, China

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Nat. Env. & Poll. Tech.
Website: www.neptjournal.com

Received: 31-07-2018
Accepted: 09-12-2018

Key Words:
Carbon emission
Construction land
Decoupling
Trend index
Hefei City

ABSTRACT

Low carbon has been one of the hottest research topics on global change and sustainable development field, and land use carbon emission is a leading research subject. Taking Hefei City as an example, this paper uses the Decoupling Theory to analyse the relationship of carbon emission and construction land expansion between 1997 and 2012. Based on the decoupling analysis, the Trend Index is established to judge the development direction of the relationship. This study focuses on solving two questions: on the one hand, the strict classification provides an accurate approach for calculating the carbon emission carried by construction land; on the other hand, the paper re-analyses the decoupling states of the two research objects that have same expected development direction, which is falling at the same time. The results show that the ideal decoupling relationship between carbon emission and construction land expansion is in the order of strong decoupling<weak decoupling<expansive negative decoupling<strong negative decoupling<recessive decoupling<weak negative decoupling. At present, the relationship of carbon emission and construction land expansion in Hefei City is in the state of weak decoupling. And according to the Trend Index, it is heading towards a good trend of development.

INTRODUCTION

Since the beginning of the 21st century, the third global green wave has continuously spread throughout the world, with climate problem and low carbon economy as the typical examples. The international community has more and more urgent common aspiration to the climate change, and low carbon has become the hotspot for the research on global change and sustainable development field. The IPCC Fifth Assessment Report pointed out that human activity has been the dominant cause of climate change, and the certainty is up to 95% (IPCC 2013). Thus, the influence degree of human activities on climate change has far exceeded natural activities. The increase of greenhouse gas, especially the CO_2 concentration, caused by human activities has become the primary source for global warming (Lu 2011). Land carries various economic and social activities of humans. Therefore, as one of the major human activities, land use change is an important factor influencing carbon cycle and leading to the increase of CO_2 concentration (Friedlingstein et al. 2010). Carbon emission caused by land use change could be over ten times than that produced by burning fossil fuels in some countries or regions (Leite et al. 2012). In early 1990s, Quay pointed out that the human influence on the carbon cycle was realized through land use activities to a large extent (Quay et al. 1992). As the construction land carries the densest human activities, the most important results of land use change and construction land expansion have a huge contribution to regional carbon emissions.

Land use carbon emission research mainly consists of three aspects. The first one is the influence of land use change on the anthropogenic carbon emission (Hankey & Marshall 2010, Zhao et al. 2015). The second is the influence of land use change on terrestrial ecosystem carbon cycle (Arevalo et al. 2011, Zhang et al. 2015), which is described in detail on the vegetation carbon pool (Nowak & Crane 2002, Sun et al. 2015) and soil carbon pool (Euliss et al. 2006, Chuai et al. 2011). The third is the low-carbon optimization of land use (Dilling & Failey 2013, Choongwan et al. 2015). Generally speaking, land use change can affect the carbon emission, and reversely, setting low-carbon targets can optimize the land use activities. However, most of the researches have not strictly distinguished the differences between construction land and non-construction land. In fact, carbon emission effect of construction land is considerably larger than that of non-construction land. The impact of land use change on carbon emission is

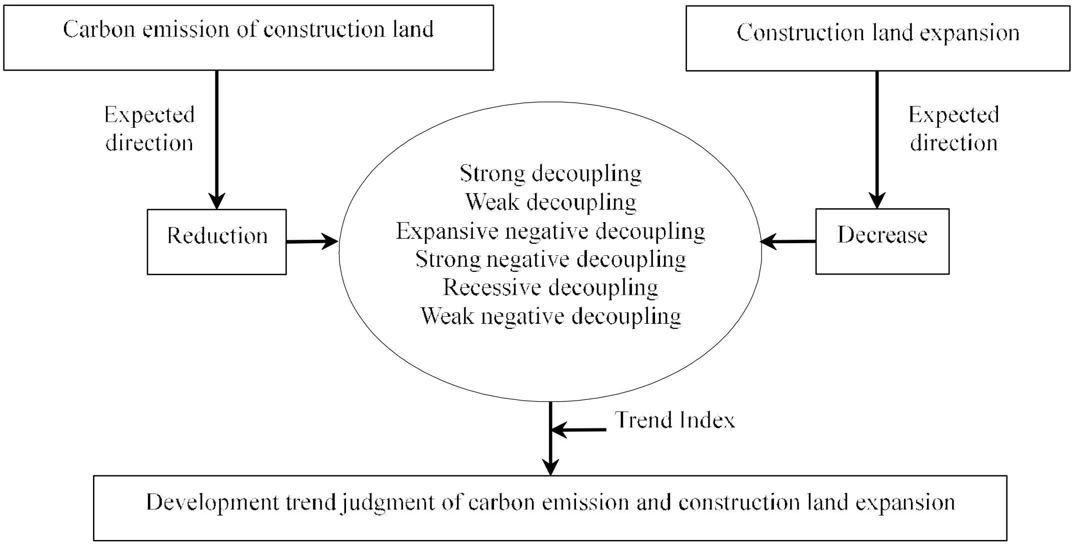

Fig. 1: The theoretical framework of the paper.

mainly concentrated in the construction land expansion (Wen 2012, Chuai et al. 2015).

As the largest developing country, China is the largest carbon emission contributor in the world (Friedlingstein et al. 2014). In September 2016, China President Jinping Xi deposited the instrument of ratification of Paris Agreement to the United Nations, and promised that China will try to reach the carbon emission peak around the year 2030. China has committed to promoting the new urbanization, and as an important manifestation, land use is now at the stage of rapid variation. This severe land use change is believed to be the major cause of the huge carbon emission. In the new urbanization process, sustainable economic and social development is facing increasingly severe pressure of carbon emission reduction. Meanwhile, a great demand for construction land in the development has led to rapid land use change, especially the increasing prominent contradiction between construction land expansion and cultivated land protection. Therefore, it has been realized that it is very necessary to deal with the relationship of carbon emission and construction land expansion. This paper aims to investigate this relationship using the Decoupling Theory and establish the Trend Index further to judge its development direction.

MATERIALS AND METHODS

Research Area

Hefei City is the capital of Anhui Province and plays an important role in the regional development strategy of China. Yangtze River Delta Agglomeration ranks one of the five largest urban agglomerations in the world, and Hefei is the sub-central city among it. Besides, Hefei is the national important research and education base, modern manufacturing industry base and comprehensive transportation hub. In recent years, Hefei's economy and society developed rapidly. According to the "S" Curve Theory of world urbanization (Northam 1979), the urbanization rate of Hefei was 30% in 1996 entering the rapid stage, and reached 70% in 2015 entering the later stage. It only takes 20 years to complete the urban development process that developed countries have spent 50-100 years on. Inevitably, there are various manifestations or hidden issues like the unlimited sprawl and extensive utilization of construction land, the large amount occupation of cultivated land, the rapid increase of carbon emission, and so on. From 1997 to 2012, the construction land in Hefei increased by more than 20 thousand hectares, cultivated land transferred out nearly 30 thousand hectares, and net carbon emission increased by more than 12 million tons (Yu 2016). Before, Hefei was just a third-tier city, but now it is positively moving towards the first-tier city beyond the second-tier period. Consequently, Hefei has relatively strong typicality in the urban development of China, and the problem during its development also has relatively strong representativeness.

It is important to note that Chaohu City, which was adjacent to Hefei City, had been cancelled administrative division in 2011, Juchao District and Lujiang County originally belonged to Chaohu were included in Hefei. Considering the sequential and spatial consistency, Juchao

Table 1: Carbon emission coefficients of the major industrial products in Hefei City (tC/t).

Product	Cement	Steel	Synthetic ammonia	Coke	Pig iron	Aluminum
Coefficient	0.136	1.060	3.273	0.560	1.350	1.599

Table 2: Carbon emission coefficients of the respiration of animals in Hefei City (tC/capita).

Animal	Human	Cow	Pig	Sheep	Poultry	Rabbit
Coefficient	0.079	0.796	0.082	0.042	0.013	0.008

Table 3: Carbon emission coefficients of major food consumption types in Hefei City (kgC/kg).

Type	Cereal	Vegetable	Edible oil	Meat	Aquatic product	Egg	Wine	Tea	Fruit	Milk
Coefficient	0.329	0.027	0.767	0.255	0.143	0.151	0.041	0.338	0.050	0.063

District and Lujiang County are not considered in this paper, and the research area included only the original Hefei City.

Data Sources

The data used in this study can be categorized into three types as stated below.

Statistical data: Output of industrial products, animal number, food consumption and other data were from Hefei Statistical Yearbook (1998-2013), waste incineration quantity was from China Statistical Yearbook (1998-2013), and energy consumption was from China Energy Statistical Yearbook (1998-2013).

Empirical data: The carbon emission coefficients were referred to the research achievements of scholars and research institutions; the net heating value of energy was from China Energy Statistical Yearbook.

Investigation data: The unpublished economic and social statistic data were obtained from the investigation of Hefei Municipal Bureau of Statistics. Construction land data of Hefei City during 1997-2012 were obtained from the investigation of Land Surveying and Planning Institute of Anhui Province.

Methodology

Theoretical framework: The concept of the decoupling originated from physics which presents that the original coupling relationship between two or more physical variables no longer exist. At the end of the last century, the scholars in Organization for Economic Co-operation and Development introduced the decoupling theory into the field of environment research. The decoupling used here is defined as the rupture of the coupling relationship between economic growth and environmental impact, and is classified as two types: absolute decoupling and relative decoupling (OECD 2002). Later, the outstanding development for the decoupling theory was made by Vehmas and Tapio. Vehmas termed it as de-linking and re-linking, and defined six levels of the whole linking process to analyse environmental stress and economic growth (Vehmas et al. 2003). Modified from Vehmas' framework, Tapio proposed eight levels of decoupling state to study the relationship of transport volume growth and economic growth (Tapio 2005). After that, the decoupling theory has been widely applied in multiple researches, such as construction land expansion and economic growth (Zhong et al. 2010), energy consumption and industrial output (Luken & Piras 2011), cultivated land loss and economic growth (Song 2014), greenhouse gas emission and economic growth (Vavrek & Chovancova 2016), and so on.

Referring to the previous researches, this study proposes a decoupling model for analysing the relationship between carbon emission and construction land expansion. In this model, the decoupling relationships are qualitatively defined as six levels:

- Strong decoupling
- Weak decoupling
- Expansive negative decoupling
- Strong negative decoupling
- Recessive decoupling
- Weak negative decoupling

Most researches have shown that the relatively good relationship is strong decoupling>weak decoupling >expansive negative decoupling>strong negative decoupling>recessive decoupling>weak negative decoupling. For example, as for the economic growth and environmental impact, we expect that these two elements could realize strong decoupling. In other words, economic growth cannot be achieved at the cost of environmental damage. However, for many other research objects, the expectation of the elements might rise or fall at the same time like the two variables of this article, carbon emission and construction land expansion, so that the decoupling state of them should be re-analysed.

For carbon emission and construction land expansion, there exist a variety of scenarios. For instance, carbon emission increases while construction land remains stable or reduces, the increasing rate of carbon emission is higher or lower than that of construction land, carbon emission decreases while construction land remains stable or reduces, and the decreasing rate of carbon emission is higher or lower than that of construction land. Under the traditional decoupling analysis, the strong decoupling state of the two is that the carbon emission will not increase with the expansion of construction land. In other words, when carbon emission increases, construction land remains stable or reduces. Obviously, this is not the expected ideal state. The expected ideal scenario is that carbon emission decreases when construction land remains stable or reduces. Therefore, the results of original decoupling analysis need to be modified. As for the decoupling level of carbon emission and construction land expansion, we have strong decoupling<weak decoupling<expansive negative decoupling<strong negative decoupling<recessive decoupling<weak negative decoupling. The ideal state of the two is weak negative decoupling. Moreover, since the decoupling theory only analyses the state between elements and cannot directly reflect the development direction of this state, we establish the Trend Index based on the results of decoupling analysis in this research, so as to judge the development direction of the two elements. Fig. 1 illustrates the theoretical framework.

Table 4: Definition of decoupling states between carbon emission and construction land expansion.

State	c	t	Definition
Strong decoupling	$c > 0$	$t \leq -\frac{c}{1+c}$	Carbon emission increases year by year, while construction land area remains stable or decreases. ($c > 0, l \leq 0$)
Weak decoupling	$c > 0$	$-\frac{c}{1+c} < t < 0$	Carbon emission increases year by year, as well as construction land area; but the increasing rate of construction land area is smaller than that of carbon emission. ($c > 0, l > 0, l < c$)
Expansive negative decoupling	$c > 0$	$t > 0$	Carbon emission increases year by year, as well as construction land area; but the increasing rate of construction land area is greater than that of carbon emission. ($c > 0, l > 0, l > c$)
Strong negative decoupling	$c < 0$	$t > -\frac{c}{1+c}$	Carbon emission decreases year by ye ar, while construction land area increases. ($c < 0, l > 0$)
Recessive decoupling	$c < 0$	$t < 0$	Carbon emission decreases year by year, as well as construction land area; but the decreasing rate of construction land area is greater than that of carbon emission. ($c < 0, l < 0, l < c$)
Weak negative decoupling	$c < 0$	$0 < t < -\frac{c}{1+c}$	Carbon emission decreases year by year, as well as construction land area; but the decreasing rate of construction land area is smaller than that of carbon emission. ($c < 0, l < 0, l > c$)
Critical state I	$c > 0$	$t = 0$	Carbon emission increases year by year, as well as construction land area; and the increasing rate of construction land area is equal to that of carbon emission. ($c > 0, l > 0, l = c$)
II	$c < 0$	$t = 0$	Carbon emission decreases year by year, as well as construction land area; and the decreasing rate of construction land area is equal to that of carbon emission. ($c < 0, l < 0, l = c$)
III	$c < 0$	$t = -\frac{c}{1+c}$	Carbon emission decreases year by year, while construction land area remains stable. ($c < 0, l = 0$)

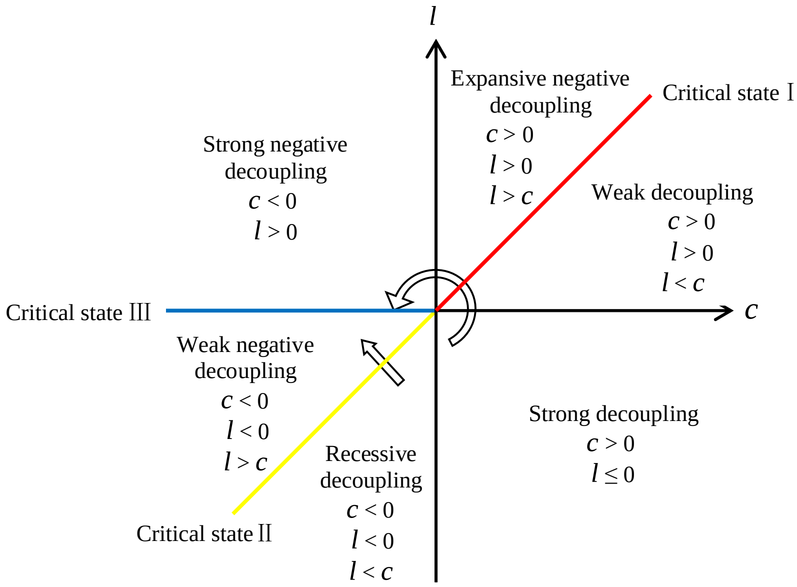

Fig. 2: Graphical representation of the decoupling states.

Calculation method for carbon emission of construction land: The most relevant researches characterize that a region's carbon emission is proportional to the region's energy consumption, in which carbon emission is contributed as the major source, and the data can be easily obtained. However, there is a problem of relatively low accounting value of carbon emission. In addition, this study investigates the relationship between carbon emission and construction land expansion. Therefore, the amount of carbon emission is correlated with construction land, and the carbon emission of non-construction land should be ignored. To these, the following two treatments are considered in this investigation. One is to comprehensively account the carbon emission projects of construction land. Besides the energy consumption, it includes the industrial production, waste burning, respiratory and food consumption. The other is to eliminate the carbon emission carried out by non-construction land in energy consumption accounting. The calculation approaches are described as follows:

Industrial production

$$C_{industry} = \sum_{i=1}^{n} Q_i \times V_i \quad ...(1)$$

Where, $C_{industry}$ is the carbon emission of industrial production, Q_i is the output of the *i*th product, V_i is carbon emission coefficient of the i^{th} product (Table 1), *n* is the number of product types (Fang et al. 1996, Zhao et al. 2013).

Waste burning

$$C_{burn} = Q_{burn} \times \alpha \times EF \quad ...(2)$$

Where, C_{burn} is the carbon emission of waste burning, Q_{burn} is burning amount, *a* is the percentage of carbon content (default value is 50%), *EF* is complete burning rate (default value is 95%) (Cai et al. 2009).

Respiration

$$C_{respiration} = \sum_{i=1}^{n} Num_i \times V_i \quad ...(3)$$

Where, $C_{respiration}$ is the carbon emission of respiration, Num_i is the number of the *i*th type of animal, V_i is the carbon emission coefficient of the respiration of the i^{th} type of animal (Table 2), *n* is the number of animal types (Kuang et al. 2010, Chuai 2013). Although small animals like poultry and rabbit have relatively small coefficients of carbon emission, there are considerable amounts.

Food consumption

$$C_{food} = \sum_{i=1}^{n} Q_i \times V_i \quad ...(4)$$

Where, C_{food} is the carbon emission of food consumption, Q_i is consumption quantity of the *i*th food, V_i is the

Table 5: The value range and ideal trend of the Trend Index H under different decoupling states.

State	Value range of l	Value range of c	Relationship between l and c	Value range of H	Ideal trend of H
Strong decoupling	l ≤ 0	c > 0	l ≤ 0 < c	H > 1	H trends to 1
Weak decoupling	l > 0	c > 0	l < c	0 < H < 1	H trends to 0
Expansive negative decoupling	l > 0	c > 0	l > c	H < 0	H trends to 0
Strong negative decoupling	l > 0	c < 0	c < 0 < l	H > 1	H trends to 1
Recessive decoupling	l < 0	c < 0	l < c	H < 1	H trends to 0
Weak negative decoupling	l < 0	c < 0	c < l	0 < H < 1	H trends to 1

carbon emission coefficient of the *i*th food (Table 3), *n* is the number of food consumption types (Luo et al. 2005, Flysjö et al. 2012).

Energy consumption

$$C_{energy} = \sum_{i=1}^{n} Q_i \times NCV_i \times V_i \quad ...(5)$$

Where, C_{energy} is the carbon emission of energy consumption, Q_i is consumption quantity of the i^{th} energy, NCV_i is net heating value of the i^{th} energy, V_i is the carbon emission coefficient of the *i*th energy (IPCC 2006).

The data in China Energy Statistical Yearbook show the final consumption quantity of energy in each item, including agriculture, forestry, animal husbandry, fishery, industry, construction industry, transportation industry, wholesale and retail industry, lodging and catering industry, and livelihoods of both urban and rural people. In the calculations, the effects of energy consumption of agriculture, forestry and fishery are ignored. Allow for the specific circumstance of Hefei City, livestock breeding is mainly carried out in construction land, and the main use of grassland is not grazing. Therefore, carbon emission of animal husbandry is reserved.

RESULTS AND DISCUSSION

Decoupling Model: Imitating the IPAT equation, identity equation containing carbon emission and construction land area is established:

$$L = P \times \frac{C}{P} \times \frac{L}{C} \quad ...(6)$$

Where, *L* is the area of construction land, *P* is population number, *C* is carbon emission of construction land.

Let $A = \frac{C}{P}$, which indicates the per capita carbon emission; $T = \frac{L}{C}$, which indicates the construction land area for unit carbon emission. Thus, Eq. 7 can be derived from Eq. 6:

$$L = P \times A \times T \quad ...(7)$$

In order to clearly grasp the relationship between carbon emission and construction land expansion, Eq. 7 can then be expressed as follows:

$$L = C \times T \quad ...(8)$$

Where, *l*, *c* and *t* are the annual changing rates of *L*, *C* and *T*, respectively. The subscripts 0 and *n*, of the three variables, represent the initial and end values of the corresponding variables used. Thus, $L_0 = C_0 \times T_0$, $L_n = L_0(1 + l)^n = C_n \times T_n = C_0(1 + c)^n \times T_0(1 + t)^n$. Furthermore, calculating L_n / L_0, we have:

$$(1 + l)^n = (1 + c)^n (1 + t)^n \quad ...(9)$$

Theoretically, range of *l* is $[-1, \sqrt[n]{\frac{S}{L_0}} - 1]$, where, *S* is the total land area. However, the extreme situation can never appear actually. Therefore, value of $(1 + c)^n(1 + t)^n$ can be either one of three scenarios in common sense for analysis:

Scenario 1: $l = 0$ (construction land area remains stable), $(1 + c)^n(1 + t)^n = 1$

Scenario 2: $l > 0$ (construction land area increases each year), $(1 + c)^n(1 + t)^n > 1$

Scenario 3: $l < 0$ (construction land area decreases each year), $(1 + c)^n(1 + t)^n < 1$

It can be seen that $l = 0$ is the critical condition, the critical value of *t* is $t' = -\frac{c}{1+c}$. Thus, the above three situations can be also described through *t'*:

Scenario 1: $t = t'$, $l = 0$
Scenario 2: $t > t'$, $l > 0$
Scenario 3: $t < t'$, $l < 0$

In general, the relationship of *c* and *t* can be used to judge the decoupling state between carbon emission and construction land expansion (Table 4).

From the objective laws, economic development and

Table 6: Decoupling analysis results between carbon emission and construction land expansion of Hefei City.

Year	*l*	*c*	*t*	*t'*	*H*
1997	0.0076	0.0775	-0.0649	-0.0719	0.9021
1998	0.0040	0.0364	-0.0313	-0.0351	0.8902
1999	0.0056	0.0799	-0.0688	-0.0740	0.9300
2000	0.0026	0.0995	-0.0882	-0.0905	0.9743
2001	0.0036	0.0592	-0.0525	-0.0559	0.9388
2002	0.0077	0.0617	-0.0508	-0.0581	0.8751
2003	0.0264	0.2271	-0.1636	-0.1851	0.8838
2004	0.0136	0.0009	0.0128	-0.0009	-14.5973
2005	0.0099	0.1072	-0.0879	-0.0968	0.9079
2006	0.0229	0.1495	-0.1101	-0.1300	0.8468
2007	0.0225	0.0785	-0.0519	-0.0728	0.7130
2008	0.0139	0.1113	-0.0876	-0.1001	0.8446
2009	0.0148	0.0954	-0.0736	-0.0871	0.8748
2010	0.0206	0.0821	-0.0569	-0.0759	0.6702
2011	0.0234	0.0711	-0.0445	-0.0664	0.7495
2012	0.0219	0.0538	-0.0303	-0.0511	0.5932

construction land expansion will both increase within a long period of time. The optimal state is strong decoupling, which is, economy enhances while construction land remains stable or decreases. As for the carbon emission and construction land expansion, the situation is just the opposite. Although they will both increase within a long period of time, their most ideal state is weak negative decoupling, which is carbon emission decreases while construction land also decreases. Because the expectation for economic development is increased, but the expectation for carbon emission is decreased. Thus, combining with the Table 4, the ideal decoupling relationship between carbon emission and construction land expansion is in the order of strong decoupling<weak decoupling<expansive negative decoupling<strong negative decoupling<recessive decoupling<weak negative decoupling. In order to intuitively understand the decoupling states of the two elements, Table 4 is illustrated in Fig. 2.

In Fig. 2, the circular arrow turns clockwise from the fourth quadrant to the third quadrant, which indicates that as for carbon emission and construction land expansion, the ideal trend is from strong decoupling to recessive decoupling and weak negative decoupling through weak decoupling, expansive negative decoupling and strong negative decoupling. And for the recessive decoupling and weak negative decoupling in the third quadrant, the straight arrow shows that the weak negative decoupling is better.

Trend index: From the decoupling analysis mentioned above, we can get the decoupling state between carbon emission and construction land expansion in a certain region by applying the proposed model on the data received, so as to evaluate the relationship of the two variables during a period. Also, we can use it to compare the different decoupling states of different regions in the same periods. However, only knowing the decoupling state is obviously not enough. It should be better understanding the internal relation between carbon emission and construction land expansion by finding the gap between this state and the ideal state, or the change trend of the gap whether is narrowing. Therefore, based on the decoupling analysis, the ratio of t to t' can be used to establish the Trend Index H between carbon emission and construction land expansion. And this index H can reflect the development direction of the decoupling state (Table 5).

$$H = \frac{t}{t'} = -\frac{t(1+c)}{c} = 1 - \frac{l}{c} \quad \text{...(10)}$$

Calculation results: According to the Decoupling Model and Trend Index mentioned above, the calculated l, c, t, t' and H values of Hefei City from 1997 to 2012 are tabulated in Table 6.

Obviously, the H value in 2004 was abnormal, mainly because of the sharply increased energy consumption due to natural disaster in 2003. As a result, the c value was too big in 2003 and too small in 2004. In 2003, although the c value was too big, it was still higher than l, namely that carbon emission increasing rate was still higher than construction land expansion rate. It only widened the increasing rate of carbon emission and the expansion rate of construction land. Therefore, the absolute values of t and t' increased significantly, but they were still negative. And the derived H value did not show abnormally since it is the ratio of t to t'. The c value, only 0.0009, was too small in 2004, which led to carbon emission increasing rate being lower than construction land expansion rate. Thus, the *t* value became positive while the *H* value turned to negative. At first glance, it seems that carbon emission and construction land expansion were in the state of expansive negative decoupling in 2004. Actually, it is just a temporary illusion caused by natural disaster. Of course, it is believed that the decoupling state of the two will develop to expansive negative decoupling, and will go beyond it to achieve better states in order of strong negative decoupling, recessive decoupling and weak negative decoupling.

In general, apart from the year 2004, carbon emission and construction land expansion in Hefei City were in the state of weak decoupling during 1997 to 2012, which was $c > l > 0$, and the increasing rate of carbon emission *c* was basically 3-10 percentage points higher than construction land expansion rate *l*. The negative value of *t* indicated that the changing rate of carbon emission quantity to unit construction land area was consistently in a downward trend. However, it is hard to intuitively judge the changing direction of the weak decoupling by the *c*, *l* or *t* values. It means that we cannot clearly point out that the current weak decoupling will develop to expansive negative decoupling or strong decoupling. At this time, the significance of the Trend Index *H* is reflected. When in the weak decoupling state, the value of *H* is (0, 1), and the closer to 0 the better. According to the calculation results, the *H* value gradually reduced during the study period, especially after the year 2000. Although the natural disaster led to the *H* value being abnormal in 2004 and rebounding in 2005, it did not affect the overall trend.

CONCLUSIONS

This study analyses the relationship between carbon emission and construction land expansion in Hefei City during the period of 1997 to 2012 using the proposed decoupling model. Furthermore, the trend index is established to judge the development direction of the decoupling state.

The results show that the ideal decoupling state between carbon emission and construction land expansion is in the order of strong decoupling<weak decoupling<expansive negative decoupling<strong negative decoupling <recessive decoupling<weak negative decoupling. From 1997 to 2012, the relationship of carbon emission and construction land expansion in Hefei City is in the state of weak decoupling. And the trend index indicates that this state is heading towards a good trend of development. Objectively speaking, increasing rate of carbon emission *c* and expansion rate of construction land *l* in Hefei City will not be negative at the same time in a relatively long period of time. It means that it is hard to reach the state of recessive decoupling or weak negative decoupling. Also, either $c < 0$ or $l < 0$ will not appear in several years later. Therefore, the state of expansive negative decoupling or strong negative decoupling is unlikely to show up in the short term. However, China has promised to reach the carbon emission peak around the year 2030, which means the situation of $c < 0$ will appear around 2030. Combining with the conclusions of this article, further verification is still needed on whether construction land expansion will be controlled, gradually become stable, or even negatively increase nearly a decade later.

There are two innovation attempts. First, this research accurately calculates the carbon emission just carried by construction land. Since the research objects of this paper, carbon emission accounting must be strictly correlated with construction land, the accounting projects cannot include carbon absorption and carbon emission of other land use types. Especially, when accounting energy consumption project, we chose the method of industry division to eliminate the carbon emission carried by non-construction land. Second, this research reorders the decoupling states of two research objects that have consistent expected trend, which is rising or falling at the same time. Traditionally, the decoupling theory is usually used in analysing the two elements that we hope they develop in opposite directions. Such as environment and economic, we would like to reduce the environmental damage during the economic growth; another, construction land and economy, we devote to make construction land area stable or even being negative growth in economic increasing process. In this article, we propose the decoupling model to analyse the two elements as carbon emission and construction land expansion that have same expected development directions.

ACKNOWLEDGEMENT

This work was financially supported by Philosophy and Social Science Fund of Anhui Province “Research on optimal allocation of land resources in Anhui province based on carbon threshold” (AHSKQ2018D16).

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