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The Dataset of Indirect Carbon Emissions of Urban Residents in Provinces of China

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Abstract: Based on the input-output tables of provinces of China (no data available from Tibet, Taiwan, Hong Kong and Macao), the dataset of indirect carbon emissions (ICEs) of urban residents in provinces of China is developed. Using the input-output method to calculate ICEs, this study constructs the ICE equality and uses the LMDI-I (Logarithmic Mean Divisia Index) method to decompose the drivers of ICEs change into four categories: consumption level effects, population scale effects, ICE intensity effects, and residents' lifestyle effects. Then, the temporal and spatial characteristics of ICEs are analyzed. The dataset includes the followings: (1) ICEs of urban residents in provinces of China; and (2) consumption level effects, population scale effects, ICE intensity effects, the residents' lifestyle effects, and the corresponding relation between the industrial sector in the input-output table and the energy consuming industrial sector in the statistical yearbook. There is only one file in Excel format and 52.5 KB in size. The dataset shows the followings: (1) All provinces but Jilin show growing ICEs; (2) the effect of consumption level is one of the most important influencing factors for increasing ICEs; (3) the size of the population has a mixed effect on ICEs; (4) the most important factor that caused the reduction of ICEs in most provinces is the ICE intensity effects; and (5) the changes of the residents' lifestyle contribute little to ICEs.

Keywords: China; province; urban residents; indirect carbon emissions; Journal of Natural Resources

1 Introduction

With the mounting attention to the quality of population urbanization[1], it has become a focus of research to improve residents' living standards with only moderate indirect carbon emissions (ICEs) increase. At present, the methods of measuring ICEs mainly include the consumer product lifecycle method[2–3], the consumer lifestyle method[4–5], and the input-output method[6–9]. Of these, the input-output analysis is the most widely used method. In term of the drivers of ICEs, some scholars use grey correlation analysis[10] and multivariate regression analysis[11]. And the structural decomposition[7–12] and the LMDI[13–14] are more widely used. By analyzing the spatial and temporal evolution of influencing factors of

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ICEs, we can better identify the key areas and key factors to curb ICEs.

2 Metadata of Dataset

The metadata of the ICEs dataset based on urban residents in provincial level of China[15] is summarized in Table 1, including the dataset full name, short name, authors, year, temporal resolution, data format, data size, data files, data publisher, data sharing policy, etc.

Table 1 Metadata summary of ICEs dataset based on urban residents in provincial level of China

Items	Description
Dataset full name	Indirect carbon emissions dataset based on urban residents in provincial level of China
Dataset short name	CarbonEmissionUrbanResidentProvChina
Authors	Cui, P. P. X-9461-2018, College of Environment and Planning, Henan University; School of Geographic Science, Nanjing Normal University, cuipan3353@163.com Zhang, L. J. X-9839-2018, College of Environment and Planning, Henan University, zlj7happy@163.com
Geographical region	Urban areas in 30 Chinese provinces (excluding Hong Kong, Macao, Taiwan, and Tibet)
Year	2002, 2007, 2012
Data format	.xls Data size 52.5 KB
Data files	Including 3 Excel files: 1. The data of indirect carbon emissions of urban residents in 30 Chinese provinces; 2. The data of consumption level effects, population scale effects, indirect carbon emission effects, and resident lifestyle effects; 3. The corresponding relation between the industrial sector in the input-output table and the energy consuming industrial sector in the statistical yearbook
Foundations	National Science Foundation of China (41501588, 41671536); China Postdoctoral Science Foundation (2016M600575); Henan Province (2014CJJ065, 17A170006)
Data publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	***Data*** from the Global Change Research Data Publishing & Repository includes metadata, datasets (data products), and publications (in this case, in the *Journal of Global Change Data* & *Discovery*). ***Data*** sharing policy includes: (1) ***Data*** are openly available and can be Downloaded for free via the Internet; (2) End users are encouraged to use ***Data*** subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a *Data* redistribution license; and (4) If ***Data*** are used to compile new datasets, the 'ten percent Principal' should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[16]

3 Methods of Data Development

3.1 Algorithm Principle

In this paper, based on relevant references[13,17], the research results were formed[15,18]. The specific steps include the followings: (1) Combining the actual situation of the data, the 42 industrial sectors in the input-output table are merged into 29 sectors; and (2) the 29 industrial sectors resulting from the merging corresponds to energy consumption sectors in the *Provincial Statistical Yearbooks*. And the ICE intensity of the eight consumption categories of urban residents can be obtained from the average value of the relevant industrial sector in the input-output table.

Using the input-output method to calculate ICEs, this study constructs the ICE equality and uses the LMDI-I method to decompose the drivers of ICEs change into the consumption level effects, population scale effects, ICE intensity effects, and residents' lifestyle effects.

3.2 Methods

3.2.1 Input-output Method

The ICEs of urban residents in each province were calculated by the input-output method. The formulas are as follows:

$$E_j = D_j \times (I - A_{ij})^{-1} \tag{1}$$

$$C = \sum_{k=1}^{8} E_k \times F_k \tag{2}$$

where E_j is the ICE intensity for sector j in the input-output table, (10^4 t/10^4 Yuan), and it can represent the total carbon emissions of all industrial sectors required for unit output; D_j is the direct carbon emission intensity for sector j in the input-output tables (10^4 t/10^4 Yuan); $(I-A)^{-1}$ is the Leontiff inverse matrix; A_{ij} is the direct energy consumption coefficient matrix, and I is the unit matrix with the same order as the A. In formula (2), C is ICEs for urban resident consumption (10^4 t); k represents the categories of consumption of urban residents, k = 1, 2, 3, …, 8. (The statistics of consumption on the daily living expenses of each household in the provincial statistical yearbooks include food, clothing, housing, household equipment and services, health care, transportation and communications, education, cultural and recreational services, and other goods and services.) E_k is the ICE intensity of the k^{th} consumption type of urban residents (10^4 t/10^4 Yuan), and F_k is the urban residents' consumption of the k^{th} consumption type (10^4 Yuan).

3.2.2 LMDI-I Method

Firstly, the ICE equality is constructed as follows:

$$C = \sum_{k=1}^{8} C_k = \sum_{k=1}^{8} I_k S_k V P \tag{3}$$

where I is the ICE intensity (10^4 t/10^4 Yuan), S is the residents' lifestyle (%), V is the consumption level (10^4 Yuan), P is the population scale (10^4 people), and k is the same as above.

Secondly, the LMDI-I analysis method is used to decompose the change of ICEs:

$$\Delta C = C_t - C_0 = \Delta C_I + \Delta C_S + \Delta C_V + \Delta C_P \tag{4}$$

where ΔC is the change in ICEs for year t; and C_t and C_0 are ICEs for the base period and reporting period, respectively.

$$\Delta C_I = \sum_{k=1}^{8} W_k \ln \frac{I_{kt}}{I_{k0}} \tag{5}$$

where ΔC_I is the contribution of the ICE intensity I to the change of C, representing the ICE intensity effects.

$$\Delta C_s = \sum_{k=1}^{8} W_k \ln \frac{S_{kt}}{S_{k0}} \tag{6}$$

where ΔC_S is the contribution of the residents' lifestyle to the change of C, representing the residents' lifestyle effects.

$$\Delta C_V = \sum_{k=1}^{8} W_k \ln \frac{V_t}{V_0} \tag{7}$$

where ΔC_V is the contribution of the consumption level to the change of C, representing the consumption level effects.

$$\Delta C_P = \sum_{k=1}^{8} W_k \ln \frac{P_t}{P_0} \tag{8}$$

where ΔC_P is the contribution of the population to the change of C, representing the population scale effects.

$$W_k = \frac{C_{kt} - C_{k0}}{\ln(C_{kt}) - \ln(C_{k0})} \tag{9}$$

where W_k is the weight of consumption type k.

4 Data Results

4.1 Dataset Composition

This dataset size with 52.5 KB is archived in. xls format. The dataset includes the ICEs of urban residents in 30 provinces of China in 2002, 2007, and 2012; the data of consumption level effects, population scale effects, ICE intensity effects, residents' lifestyle effects, and the corresponding relation between the industrial sector in the input-output table and the energy consumption of the industrial sector is from the *Provincial Statistical Yearbooks*.

4.2 Data Results

1) The data of Chinese urban residents' ICEs of 30 provinces in 2002, 2007, and 2012. Figures 1 and 2 demonstrate the amount and the average annual growth rate, respectively, of ICEs of Chinese urban residents in 30 provinces in 2002, 2007 and 2012.

2) The date of increment and its influencing factors on the ICEs of Chinese urban residents from 2002−2007, 2007−2012, and 2002−2012. Tables 2−4 demonstrate the increment of ICEs and the effect of lifestyle, consumption level, population scale and ICE intensity of Chinese urban residents for these three time periods.

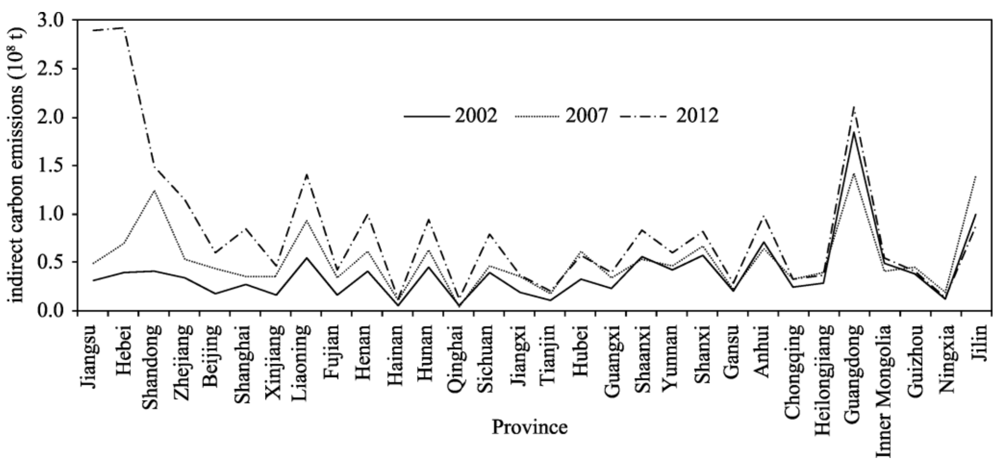

Figure 1 ICEs of urban residents in 30 provinces of China

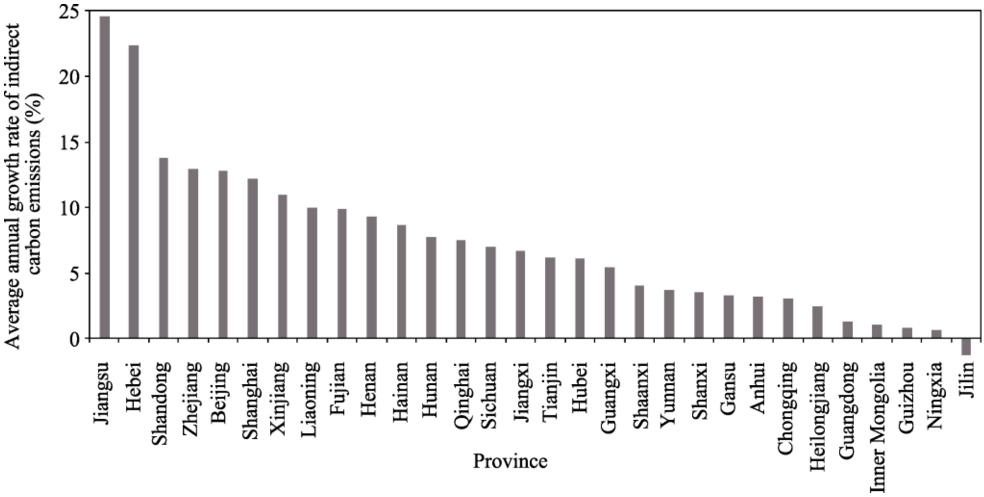

Figure 2 Average annual growth rate of ICEs of urban residents in 30 provinces of China

Table 2 Increment and decomposition effects of indirect carbon emissions from 2002 to 2007 (10^4 t)

Province	Increment of indirect carbon emissions	Indirect carbon emission intensity effects	Residents' lifestyle effects	Consumption level effects	Population scale effects
Anhui	–742.28	–2,777.09	83.88	3,946.41	–1,995.48
Beijing	2,634.87	957.979	–157.55	1,231.56	602.88
Fujian	1,742.23	210.64	31.10	1,213.97	286.53
Gansu	144.89	–1,205.87	–10.02	928.14	432.64
Guangdong	–4,209.69	–13,768.01	–6.55	7,108.44	2,456.43
Guangxi	1,034.76	–712.87	–90.73	1,165.88	672.48
Guizhou	785.59	–1,871.23	–49.76	2,165.97	540.61
Hainan	531.75	70.07	39.01	306.28	116.40
Hebei	3,138.51	–625.90	9.58	2,550.23	1,204.59
Henan	2,081.51	–1,834.50	–128.95	2,753.17	1,291.79
Heilongjiang	1,121.36	–654.78	–41.96	1,727.95	90.16
Hubei	2,893.39	802.77	–74.51	1,857.99	307.14
Hunan	1,764.39	–1,661.57	–133.23	2,538.12	1,021.06
Jilin	4,021.01	–1,979.07	–22.58	6,400.14	–377.47
Jiangsu	1,741.79	–1,426.48	40.46	2,298.35	829.46
Jiangxi	1,573.81	–474.90	–26.15	1,426.57	648.28
Liaoning	3,811.73	–975.24	150.20	4,023.82	612.95
Inner Mongolia	–732.34	–4,076.03	–162.45	2,881.52	624.61
Ningxia	616.27	–516.44	–8.06	652.82	487.95
Qinghai	–103.47	–334.74	–17.64	197.67	51.24
Shandong	8,345.04	3,179.72	32.16	4,027.76	1,105.39
Shanxi	945.70	–3,596.57	119.78	3,345.36	1,077.14
Shaanxi	–303.84	–3,582.82	–134.04	2,438.53	974.48
Shanghai	869.10	–2,298.96	159.43	1,533.84	1,474.79
Sichuan	631.94	–2,155.33	27.92	2,037.03	722.31
Tianjin	592.03	–320.57	10.66	700.22	201.72
Xinjiang	1,948.53	599.13	–80.19	830.89	598.70
Yunnan	534.32	–1791.21	–70.88	1,356.55	1,039.86
Zhejiang	1,870.50	–979.25	150.54	2,041.46	657.75
Chongqing	924.23	–1,122.35	–24.25	1,524.21	546.62

Table 3 Increment and decomposition effects of indirect carbon emissions from 2007 to 2012 (10^4 t)

Province	Increment of indirect carbon emissions	Indirect carbon emission intensity effects	Residents' lifestyle effects	Consumption level effects	Population scale effects
Anhui	3,403.31	–2,288.24	–74.54	4,482.21	1,283.88
Beijing	1,525.21	–2,018.58	14.56	2,244.15	1,285.09
Fujian	808.39	–1,937.54	–108.09	1,933.27	920.75
Gansu	635.87	–1,031.13	–10.94	1,210.51	467.43
Guangdong	6,754.71	–3,967.48	–139.54	7,743.37	3,118.36
Guangxi	619.03	–2,057.39	9.17	2,058.66	608.59
Guizhou	–467.03	–3,234.12	–49.40	2,058.66	757.83
Hainan	169.80	–545.15	–26.35	595.80	145.50
Hebei	22,265.95	12,487.13	180.88	6,509.61	3,088.33
Henan	3,806.50	–2,241.14	–88.22	4,429.91	1,705.95
Heilongjiang	–330.29	–2,573.95	–34.73	2,062.92	215.47
Hubei	–314.82	–4,256.10	–29.38	2,842.51	1,128.16
Hunan	3,196.34	–1,974.44	–23.32	3,754.49	1,439.61
Jilin	–5,218.62	–11,098.11	–239.24	5,922.07	196.66
Jiangsu	24,016.58	13,907.50	–89.09	7,458.58	2,739.60
Jiangxi	186.07	–2,356.01	25.03	1,769.01	748.05
Liaoning	4,819.43	–2,845.60	–165.03	6,417.46	1,412.59
Inner Mongolia	1,298.70	–2,638.56	7.51	3,089.08	840.68
Ningxia	–527.40	–1,738.04	–23.77	922.90	311.51
Qinghai	712.58	173.79	6.50	375.39	156.90
Shandong	2,453.43	–6,102.45	–109.72	6,654.24	2,011.36
Shanxi	1,454.21	–3,171.70	12.98	3,030.36	1,582.56
Shaanxi	3,027.16	–2,321.49	–86.60	4,025.32	1,409.94
Shanghai	4,970.12	1,202.52	–55.67	2,379.36	1,443.92
Sichuan	3,261.74	–1,300.15	31.21	3,342.97	1,187.70
Tianjin	336.51	–1,201.34	14.81	955.33	567.70
Xinjiang	1,078.23	–1,951.89	–22.10	2,317.21	735.90
Yunnan	1,287.06	–3,243.53	232.28	2973.53	1,324.78
Zhejiang	6,249.16	1,445.79	–0.77	3,379.92	1,424.22
Chongqing	–69.40	–1,996.06	–154.92	1,390.41	691.17

Table 4 Increment and decomposition effects of indirect carbon emissions from 2002 to 2012（10^4 t）

Province	Increment of indirect carbon emissions	Indirect carbon emission intensity effects	Residents' lifestyle effects	Consumption level effects	Population scale effects
Anhui	2,661.03	–5,847.62	28.27	9,611.34	–1,130.97
Beijing	4,160.09	–415.05	33.15	2,930.87	1,611.13
Fujian	2,550.62	–1,126.07	–27.27	2,729.16	974.80
Gansu	780.76	–2,381.86	–5.16	2,224.42	943.36
Guangdong	2,545.03	–20,376.06	–450.03	17,015.89	6,355.23
Guangxi	1,653.78	–2,563.06	–41.94	3,010.64	1,248.15

(***To be continued on the next page***)

(***Continued***)

Province	Increment of indirect carbon emissions	Indirect carbon emission intensity effects	Residents' lifestyle effects	Consumption level effects	Population scale effects
Guizhou	318.56	–4,746.83	–57.07	3,920.64	1,201.82
Hainan	701.55	–333.10	–34.23	820.62	248.25
Hebei	25,404.46	8,637.88	279.82	11,190.29	5,296.47
Henan	5,888.01	–4,099.03	–213.15	7,149.10	3,051.08
Heilongjiang	791.07	–2,836.04	–35.49	3,394.72	267.87
Hubei	2,578.57	–2,628.44	–122.63	4,132.17	1,197.48
Hunan	4,960.73	–3,679.29	–227.96	6,367.06	2,500.92
Jilin	–1,197.60	–10,835.89	–206.51	9,976.82	–132.02
Jiangsu	25,758.38	8,018.29	113.50	12,921.10	4,704.58
Jiangxi	1,759.87	–2,277.38	–3.16	2,807.03	1,233.38
Liaoning	8,631.15	–3,561.35	75.15	10,215.84	1,901.51
Inner Mongolia	566.36	–7,339.14	–256.40	6,558.68	1,603.23
Ningxia	88.87	–1,838.47	–41.98	1,304.31	665.02
Qinghai	609.10	–337.63	–45.46	736.41	255.78
Shandong	10,798.47	–239.65	58.41	8,527.30	2,452.41
Shanxi	2,399.92	–6,850.62	56.82	6,528.51	2,665.21
Shaanxi	2,723.32	–6,863.65	–268.83	7,186.55	2,669.25
Shanghai	5,839.22	–2,616.72	161.91	4,608.58	3,685.46
Sichuan	3,893.68	–3,983.06	–3.034	5,815.49	2,064.28
Tianjin	928.54	–1,322.47	48.78	1,528.85	673.39
Xinjiang	3,026.76	–715.96	–47.85	2,584.22	1,206.36
Yunnan	1,821.38	–5,047.21	105.93	4,337.69	2,424.96
Zhejiang	8,119.66	–316.57	301.78	5,943.14	2,191.31
Chongqing	854.83	–2,838.96	–125.64	2,690.63	1,128.79

5 Discussion and Conclusion

The ICEs is an important part of resident carbon emissions. It can not only better reflect the responsibility of reducing carbon emissions and meet the needs of carbon emission assessment, but it can also more accurately reflect the impact of human consumption behavior on climate change. It is the basis for formulating reasonable and feasible carbon emission reduction policies. Therefore, based on the input-output table, we can calculate the ICEs caused by household consumption and decompose the drivers of ICEs change into four categories. Noting that in calculating the direct carbon emission intensity (D_j) of various sectors, the total energy consumption (standard coal consumption) is calculated because of the difficulties to obtain the energy consumption of different categories in different industrial sectors. The conversion coefficient of standard coal to CO_2 is 2.497 kg/kg[18].

Author Contributions

Cui, P. P. and Zhang, L. J. carried out the overall design for the development of the dataset; Cui, P. P. collected and processed the data and designed the models and algorithms; Cui, P. P. conducted data validation, and wrote the data paper.

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