

Supporting information for

The Carbon Emissions of Chinese Cities

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Number of pages: 9

Number of tables: 6

Table S1

Definition and characteristics of the 12 Chinese cities and 10 global cities in year 2005 of this study

City	Population (thousand persons)	Total area (km ²)	GDP (million PPP \$U.S.)	Population density (persons/km ²)	Per capita income (PPP \$U.S.)
Beijing	15,380	16,411	199,700	937	5,174
Tianjin	10,430	11,919	62,400	875	3,193
Shanghai	17,780	6,341	265,500	2,804	7,737
Hangzhou	7,500	16,596	85,400	452	4,024
Nanjing	6,680	6,582	69,900	1,015	3,673
Wuxi	5,570	4,788	81,400	1,163	4,018
Guangzhou	9,580	7,434	149,500	1,289	5,026
Zhengzhou	7,160	7,446	48,200	962	2,786
Wuhan	8,580	8,494	64,900	1,010	2,785
Chongqing	27,980	82,400	89,100	340	2,199
Lanzhou	3,140	13,086	16,400	240	2,310
Shenyang	7,400	12,980	60,400	570	2,853
Bangkok (city)	5,660	1,569	unknown	3,607	7,560
Barcelona (city)	1,610	100	unknown	16,056	27,403
Cape Town (city)	3,500	2,454	unknown	1,425	9,035
Denver (city and county)	580	397	unknown	1,460	42,476
Geneva (Ganton)	430	282	unknown	1,532	32,110
London (GLA)	7,360	1,579	unknown	4,664	38,066
Los Angeles (county)	9,520	10,518	unknown	905	31,049
New York City	8,170	789	unknown	10,355	46,221
Prague (GPR)	1,180	496	unknown	2,382	21,595
Toronto (GTA)	5,560	7,195	unknown	772	33,529

Note:

1. The data of 12 Chinese cities are all from the local statistical materials (1-12)
2. GDP and Per capita income are converted to PPP \$U.S. based on the *implied PPP conversion rate national currency per current international dollar* from <http://www.econstats.com/weo/V013.htm>
3. The data of 10 global cities are derived from Kenney et al's study (13).

Table S2**Carbon accounting scope of this study**

WRI/WBCSD	Spatial boundary	Life-cycle perspective	Components	Measure
Scope 3	Out of boundary energy use (and further out of boundary emissions, not included in Scope 2)	Production chain emissions	*Embodied emissions from food and materials consumed in cities *Emissions upstream of electric power plants *Upstream emissions from fossil fuel use *Combustion of aviation and marine fuels	
			*Out of boundary waste (landfill) emissions *Out of boundary district heating emissions	ICLEI and This Study
Scope 2	In boundary electricity use related emissions		*Out of boundary electricity emissions at power plant	
Scope 1	In boundary emissions	Single process emissions	*In boundary fossil fuel combustion (<u>including industrial, transportation, household and commercial energy used</u>) *In boundary waste (landfill) emissions *In boundary industrial processes and product use *In boundary agriculture, forestry and other land use	IPCC

Table S3**Carbon emission factors of six major power grids from 2004 to 2008, t CO₂/million KWh**

Grid name	Covered cities	2004	2005	2006	2007	2008
Northeast China	Shenyang	940	956	980	905	871
North China	Beijing, Tianjin	913	927	892	867	874
Central China	Zhengzhou, Wuhan, Chongqing	724	697	681	659	555
East China	Shanghai, Hangzhou, Nanjing, Wuxi	741	764	743	720	688
Northwest China	Lanzhou	695	704	699	691	701
South China	Guangzhou	631	668	667	641	552

Note:

1. The emission factors in 2004 are the average of 2003 and 2005.

Table S4**Carbon emission intensities of Chinese cities from 2004 to 2008, t CO₂/million USD**

City	2004	2005	2006	2007	2008
Beijing	889	428	383	348	323
Tianjin	469	409	397	396	351
Shanghai	319	295	295	274	256
Hangzhou	467	454	439	406	362
Nanjing	534	465	428	382	337
Wuxi	689	624	590	584	546
Guangzhou	363	355	326	297	263
Zhengzhou	966	944	861	821	729
Wuhan	1,465	1,459	1,355	1,191	1,004
Chongqing	722	729	753	773	700
Lanzhou	2,953	2,737	2,474	2,655	2,472
Shenyang	676	692	711	551	550
China	1,057	1,014	955	875	835
World	683	647	614	565	521

Note:

1. In order to compare with China and world average levels, we present the carbon emissions intensity including coal, oil and gas consumptions of Chinese cities;
2. The carbon emissions information of China and the world were from BP statistical review of world energy (14);
3. The GDP data of Chinese cities was obtained from the Statistical Yearbook (1-12), and converted to PPP USD based on the implied PPP conversion rate national currency per current international dollar from <http://www.econstats.com/weo/V013.htm>;

Table S5**The top 10 subsectors of carbon emissions in industry energy sectors for various cities**

Beijing	Tianjin	Hangzhou	Nanjing	Wuxi	Guangzhou	Zhengzhou	Chongqing	Lanzhou	Shenyang
Electricity/ heat production and supply	Ferrous metal smelting and rolling processing	Electricity/ heat production and supply	Electricity/ heat production and supply	Electricity/ heat production and supply	Electricity/ heat production and supply	Electricity/ heat production and supply	Electricity/ heat production and supply	Petroleum processing, coking and nuclear fuel	Electricity/ heat production and supply
Ferrous metal smelting and rolling processing	Chemical materials and products manufacturing	Textile	Chemical materials and products manufacturing	Ferrous metal smelting and rolling processing	Ferrous metal smelting and rolling processing	Non-ferrous metal smelting and rolling processing	Coal Mining and Dressing	Electricity/ heat production and supply	Coal Mining and Dressing
Non-metallic mineral products	Petroleum processing, coking and nuclear fuel	Ferrous metal smelting and rolling processing	Non-metallic mineral products	Chemical materials and products manufacturing	Textile	Non-metallic mineral products	Non-ferrous metal smelting and rolling processing	Chemical materials and products manufacturing	Chemical materials and products manufacturing
Petroleum processing, coking and nuclear fuel	Electricity/ heat production and supply	Non-metallic mineral products	Ferrous metal smelting and rolling processing	Textile	Paper and Paper Products	Ferrous metal smelting and rolling processing	Chemical materials and products manufacturing	Ferrous metal smelting and rolling processing	Non-metallic mineral products
Chemical materials and products manufacturing	Non-ferrous metal smelting and rolling processing	Paper and Paper Products	Petroleum processing, coking and nuclear fuel	Chemical fiber manufacturing	Chemical materials and products manufacturing	Coal Mining and Dressing	Ferrous metal smelting and rolling processing	Non-metallic mineral products	Pharmaceutical Manufacturing
Building industry	Petroleum and natural gas mining industry	Chemical materials and products manufacturing	Communications equipment, computers and other electronic equipment manufacturing	Non-metallic mineral products	Petroleum processing, coking and nuclear fuel	Chemical materials and products manufacturing	Non-ferrous metal smelting and rolling processing	Chemical materials and products manufacturing	General equipment manufacturing
Transport Equipment	Transport Equipment	Chemical fiber manufacturing	Transport Equipment	Communications equipment, computers and other electronic equipment manufacturing	Metal products industry	Paper and Paper Products	Transport Equipment	Coal Mining and Dressing	Transport Equipment
Communications equipment, computers and other electronic equipment manufacturing	Communications equipment, computers and other electronic equipment manufacturing	General equipment manufacturing	General equipment manufacturing	Electrical machinery and equipment manufacturing	Plastic Products g	Textile	Building industry	Chemical fiber manufacturing	Non-ferrous metal smelting and rolling processing
Beverage Manufacturing	Building industry	Rubber Products	Chemical fiber manufacturing	Metal products industry	Beverage Manufacturing	Food Manufacturing	Textile	Special equipment manufacturing	Educational and Sports goods manufacturing
General equipment manufacturing	Metal products industry	Plastic Products	Plastic Products	General equipment manufacturing	Farm products processin	Special equipment manufacturing	Petroleum processing, coking and nuclear fuel	Pharmaceutical Manufacturing	Electrical machinery and equipment manufacturing

Table S6**Per capita carbon emissions of Chinese cities from 2004 to 2008, t CO₂/person**

City	2004	2005	2006	2007	2008
Beijing	7.50	5.56	5.50	5.50	5.24
Tianjin	4.19	4.20	4.63	4.95	4.96
Shanghai	4.01	4.41	4.86	4.97	4.86
Hangzhou	5.35	5.87	6.55	6.84	6.68
Nanjing	5.13	4.72	4.77	4.67	4.38
Wuxi	10.25	11.28	12.35	13.53	13.64
Guangzhou	6.44	7.07	7.52	7.53	7.21
Zhengzhou	5.52	6.35	6.91	7.66	7.71
Wuhan	10.31	11.82	12.37	12.47	12.49
Chongqing	1.82	2.05	2.37	2.72	2.86
Lanzhou	14.21	14.44	14.53	16.82	16.98
Shenyang	5.08	5.99	7.35	6.90	7.79
China	3.82	4.19	4.57	4.90	5.21
World	4.46	4.53	4.61	4.69	4.71

Note:

1. In order to compare with China and world average levels, we present the per capita carbon emissions including coal, oil and gas consumptions of Chinese cities;
2. The carbon emissions information of China and the world were from BP statistical review of world energy (14);
3. Population for each Chinese city is the average annual population, and populations for China and the world are mid-year populations (1-12);

References

- [1] Beijing Municipal Statistics Bureau (BMSB). 2005-2009. Beijing Statistical Yearbook 2004-2008; China Statistics Press: Beijing, China.
- [2] Chongqing Municipal Statistics Bureau (CMSB). 2005-2009. Chongqing Statistical Yearbook 2004-2008; China Statistics Press: Beijing, China.
- [3] Guangzhou Municipal Statistics Bureau (GMSB). 2005-2009. Guangzhou Statistical Yearbook 2004-2008; China Statistics Press: Beijing, China.
- [4] Hangzhou Municipal Statistics Bureau (HMSB). 2005-2009. Hangzhou Statistical Yearbook 2004-2008; China Statistics Press: Beijing, China.
- [5] Lanzhou Municipal Statistics Bureau (LMSB). 2005-2009. Lanzhou Statistical Yearbook 2004-2008; China Statistics Press: Beijing, China.
- [6] Nanjing Municipal Statistics Bureau (NMSB). 2005-2009. Nanjing Statistical Yearbook 2004-2008; China Statistics Press: Beijing, China.
- [7] Shanghai Municipal Statistics Bureau (SMSB). 2005-2009 a. Shanghai Statistical Yearbook 2004-2008; China Statistics Press: Beijing, China.
- [8] Shenyang Municipal Statistics Bureau (SMSB). 2005-2009 b. Shenyang Statistical Yearbook 2004-2008; China Statistics Press: Beijing, China.
- [9] Tianjin Municipal Statistics Bureau (TMSB). 2005-2009. Tianjin Statistical Yearbook 2004-2008; China Statistics Press: Beijing, China.
- [10] Wuhan Municipal Statistics Bureau (WMSB). 2005-2009 a. Wuhan Statistical Yearbook 2004-2008; China Statistics Press: Beijing, China.
- [11] Wuxi Municipal Statistics Bureau (WMSB). 2005-2009 b. Wuxi Statistical Yearbook 2004-2008; China Statistics Press: Beijing, China.
- [12] Zhengzhou Municipal Statistics Bureau (ZMSB). 2005-2009. Zhengzhou Statistical Yearbook 2004-2008; China Statistics Press: Beijing, China.
- [13] Kennedy, C.; Steinberger, J.; Casson, B.; Hansen, Y.; Hillman, T.; Havránek, M.; Pataki, D.; Phdungsilp, A.; Ramaswami, A.; Mendez, G. Greenhouse gas emissions from global cities. *Environ. Sci. Technol.* 2009, 43, 7297-7302
- [14] BP Global, 2010. BP Statistical Review of World Energy. Available at <<http://www.bp.com/statisticalreview>>.