Supplementary Information

For

Status assessment and probabilistic health risk modeling of Polycyclic Aromatic Hydrocarbons (PAHs) in surface soil across China

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List of supporting information

Table S1 The basic information of soils in 207 examined areas in China

	Region	Number of samples	Land type	$\sum_{16}$PAHs concentration (ug/kg)		Reference
				Mean	Range	
1	Hefei, Anhui	12	Agriculture soil	268.73	36.5-1031.8	Wu et al. (2020)
2	Binzhou, Shandong	89	Agriculture soil	149.8	31.5-1399.4	Qiu et al. (2019)
3	Ningde, Fujian	62	Agriculture soil	406	/	Zheng et al. (2019)
4	Huaibei, Anhui	14	Agriculture soil	174	37.5-1382	Zhang et al. (2019)
5	Huaibei, Anhui	7	Agriculture soil	52.6	27.2-68.8	Zhang et al. (2019)
6	Ningbo, Zhejiang	62	Agriculture soil	311.19	34.04-1990.38	Li et al. (2019)
7	Shanghai	70	Agriculture soil	928.16	23.16-21250.25	Zhang et al. (2019)
8	Dongying, Shandong	80	Agriculture soil	36.08	4.25-119.94	Shan et al. (2019)
9	Tianjin	12	Agriculture soil	368	229-773	Xu et al. (2018)
10	Changchun, Jilin	32	Agriculture soil	877.23	602.12-1271.87	Chen et al. (2018)
11	Jilin	45	Agriculture soil	740.21	491.65-1007.73	Wu et al. (2018)
12	Jiangsu	61		118	27-753	Chen et al. (2018)
13	Henan	227	Agriculture soil	128	14-1246	Yuan et al. (2014)
14	Tianjin	30	Agriculture soil	941.27	58.53-3137.9	Yang et al. (2013)
15	Qingdao,Shandong	54		1081.22	10.28-8925.16	Shi et al. (2017)
16	Tianjin	60	Agriculture soil	613.1	228.6-14722.1	Jiang et al. (2011)

17	Guangdong	231	Agriculture soil	316.5	ND-4079	Li et al. (2007)
18	Luqiao, Zhejiang	20	Agriculture soil	328.8	39.1-707.7	Tang et al. (2010)
19	Hangzhou, Zhejiang	69	Urban soil	611.28	180.77-1981.45	Tang et al. (2010)
20	Zhejiang	100	Agriculture soil	303	/	Yu et al. (2014)
21	Guangdong	10	Agriculture soil	705	237-1280	Sun et al. (2017)
22	Guangdong	14	Paddy soil	271	189-412	Wang et al. (2012)
23	Beijing	40	Agriculture soil	336.4	31.6-1475	Wang et al. (2012)
24	Beijing	31	Urban soil	3917	366-27825	Wang et al. (2010)
25	Guangzhou, Guangdong	30	Agriculture soil	116	23.5-231	Tang et al. (2005)
26	Beijing	233	Urban soil	1228.1	93.3-13141.5	Zheng et al. (2014)
27	Shanghai	36	Agriculture soil	665.8	92.2-2062.7	Peng et al. (2016)
28	Shanghai	55	Urban soil	3290	347-17900	Jiang et al. (2009)
29	Nanjing, Jiangsu	10	Agriculture soil	1060	21.5-3350	Zhang et al. (2006)
30	Ningbo, Zhejiang	134	Agriculture soil	221	2.8-4167	Zhang et al. (2006)
31	Guiyu, Guangdong	119	Agriculture soil	386.68	100.45-1040.76	Zhang et al. (2006)
32	Changshu, Jiangsu	29	Agriculture soil	4586.6	635-30518.9	Wang et al. (2015)
33	Changshu, Jiangsu	28	Agriculture soil	640.6	126.8-1820.8	Feng et al. (2011)
34	Jiangsu	67	Agriculture soil	471.3	189.5-1071.4	Wang et al. (2017)
35	Tianjin	87	Agriculture soil	619.86	29.65-6734.74	Cao et al. (2017)
36	Tianjin	60	Agriculture soil	1295.79	22.86-14722.14	Cao et al. (2017)

37	Longtang, Guangdong	27	Agriculture soil	180	-	Wang et al. (2017)
38	Minjiang, Fujian	16		480.28	70.7-1667.83	Chen et al. (2015)
39	Shiyan, Hubei	10	Agriculture soil	41.3	4.04-181	Chen et al. (2015)
40	Shanghai	41	Agriculture soil	339	17.2-3775	Huang et al. (2014)
41	Beijing	122	Park soil	460	66-6867	Sun et al. (2016)
42	Hebei	38	Wetland soil	42.42	7.3-191.48	Hou et al. (2015)
43	Shanghai	57	Urban soil	1970	83.3-7220	Wang et al. (2013)
44	Jiangsu	243		266.6	10.1-3058.6	Yang et al. (2020)
45	Yichang, Hubei	12		87.66	18.4-392.29	Qu et al. (2020)
46	Yichang, Hubei	12		133.84	54-463.08	Xing et al. (2020)
47	Tianjin	1	Agriculture soil	1082.8	/	Tao et al. (2004)
48	Tianjin	1	Agriculture soil	6248.5	/	Tao et al. (2004)
49	Tianjin	210		932	58.2-9160	Shi et al. (2020)
50	Huainan, Anhui	47		528.06	258.67-1797.9	Zhang et al. (2020)
51	Jilin	51	Agriculture soil	589.9	372.9-767.2	Chen et al. (2018)
52	Dalian, Liaoning	49		2580	42.8-28600	Wang et al. (2020)
53	Baoding, Hebei	250		225	25-15155	Liang et al. (2019)
54	Shaanxi	33	Agriculture soil	732	66.2-2633	Qi et al. (2019)
55	Delta area	330		269	21-2034	Li et al. (2020)
56	Shanghai	20		484	62-1481	Li et al. (2020)
57	Zhejiang	108		278	21-1844	Li et al. (2020)
58	Jiangsu	94		315	22-2034	Li et al. (2020)

59	Anhui	108		179	23-1000	Li et al. (2020)
60	Shandong	196	Agriculture soil	407.4	152.2-1317.7	Chao et al. (2017)
61	Suzhou,Jiangsu	80	Agriculture soil	352.94	/	Li et al. (2020)
62	Beijing	41		489.6	189.3-888.7	Liu et al. (2018)
63	Dongying,Shandong	138		382.5	278.7-733.5	Wen et al. (2018)
64	Shenzhen,Guangdong	27	Agriculture soil	139.3	/	Zhang et al. (2016)
65	Handan, Hebei	239	Agriculture soil	689.6	/	Liu et al. (2017)
66	Tianjin	12	Agriculture soil	368	229-773	Wei et al. (2018)
67	Changzhi, Shaanxi	32	Agriculture soil	2780.4	250.49-9387.26	Liu et al. (2016)
68	Shanghai	26	Agriculture soil	1552	223-8214	Tong et al. (2018)
69	Fujian	78	Agriculture soil	223.85	12.9-2271.03	Ding et al. (2018)
70	Lanzhou, Gansu	62	Urban soil	2360	82.2-10900	Jiang et al. (2016)
71	Shaanxi	36	Agriculture soil	691	247-1410	Duan et al. (2015)
72	Tibet	41		52.34	26.3-126.64	Yuan et al. (2017)
73	Xiangfen,Shaanxi	128		723	52-10524	Tao et al. (2017)
74	Quanzhou, Fujian	10		119.88	63.22-281.48	Yang et al. (2013)
75	TIbet	44		9.21	0.43-26.66	Yuan et al. (2015)
76	Tibet	41		59.9	5.54-389	Wang et al. (2014)
77	Shanghai	154		807	18.8-6320	Wang et al. (2015)
78	Guiyu, Guangdong	18	Agriculture soil	364	174-510	Xu et al. (2016)

79	Henan	227	Agriculture soil	129.5	15.4-1247.6	Yang et al. (2012)
80	Liaoning	55	wetland, Agriculture soil	550	106-3148	Ma et al. (2014)
81	Qizhou,Shaanxi	247	Agriculture soil	202	ND-782	Zhao et al. (2014)
82	Shanghai	54		1700	62.4-31900	Liu et al. (2010)
83	Beijing	127	Urban soil	1082.6	8.5-13126.6	Liu et al. (2010)
84	Nanjing	126	Vegetable soil	178.37	21.91-533.84	Yin et al. (2008)
85	Jiangsu	30		397	8.6-3881	Ping et al. (2007)
86	Beijing	30	Urban soil	1637	467-5470	Li et al. (2006)
87	Shantou, Guangdong	115	Agriculture soil	318.2	22.1-1256.9	Rong et al. (2007)
88	Chengdu, Sichuan	245		3234	13-75432	Xing et al. (2011)
89	Liaohe, Liaoning	30		287	235-374	Ma et al. (2014)
90	Jiangxi	1758		195	1.86-3810	Teng et al. (2015)
91	Wenling, Zhejiang	150	Agriculture soil	407.3	58.5-1332.2	He et al. (2019)
92	Wenling, Zhejiang	129	Agriculture soil	590.4	190.8-1921.5	He et al. (2019)
93	Taiyuan, Shaanxi	19	Agriculture soil	924.05	132.82-6594.63	Li et al. (2014)
94	Guangdong	37	Agriculture soil	218	/	Liu et al. (2010)
95	Guangdong	14	Paddy soil	253	/	Liu et al. (2010)
96	Jiaxing, Zhejiang	12		229.19	61.48-846.27	Zhang et al. (2011)

97	Tianjin	87	Agriculture soil	619.86	29.65-6734.74	Chen et al. (2015)
98	Tianjin	60	Agriculture soil	1295.79	22.86-14722.14	Chen et al. (2015)
99	Shunde, Guangdong	8	Agriculture soil	188	105-265	Yong et al. (2008)
100	Huangyan, Zhejiang	30	Rural soil	116	23.5-231	Zheng et al. (2014)
101	Baise, Guangxi	32		565.8	16.8-6437	Shi et al. (2015)
102	Yulin, Shanxi	38		1581.87	110.22-4934.13	Wang et al. (2019)
103	Huojia, Henan	20	Agricultural soil	24.2	6.91-72.4	Feng et al. (2017)
104	Fushun, Liaoning	91	Agricultural soil	2.22	0.66-12.36	Li et al. (2008)
105	Liaohe, Liaoning	31		1001.9	704.7-1804.5	Lang et al. (2012)
106	Kaiyuan, Liaoning	46	Paddy soil	331	72-1448	Feng et al. (2013)
107	Kaiyuan, Liaoning	56		32	7-133	Feng et al. (2013)
108	Kaiyuan, Liaoning	41	Agricultural soil	448	50-3309	Feng et al. (2013)
109	Xianyang, Shanxi	59	Agricultural soil	210.31	16.68-1938.33	Wang et al. (2016)
110	Kunming, Yunnan	8		394.52	101.64-693.3	Yang et al. (2015)
111	Beijing	111	Agricultural soil	181.5	/	Peng et al. (2016)
112	Changzhi, Shaanxi	30	Agricultural soil	3455	/	Jiao et al. (2017)
113	Shanghai	36	Agricultural soil	756.8	92.2-2062.7	Jiang et al. (2011)

114	Tibet	44		6.09	1.5-29.88	He et al. (2015)
115	Huizhou, Guangdong	42		123.09	35.4-534.5	Jin et al. (2009)
116	Changzhi, Shaanxi	203	Agricultural soil	917	9-10514	Liu et al. (2017)
117	Shanghai	16	Agricultural soil	360	260-540	Jia et al. (2017)
118	Heshan, Guangxi	17		1280.12	79.56-4256.96	Huang et al. (2016)
119	Songhuajiang,Helongjiang	18		30.1	209-870	Ma et al. (2013)
120	Liaohe, Liaoning	31		675.4	293.4-1735.9	Wang et al. (2011)
121	Xian, Shanxi	45		1246	149.9-5770	Bao et al. (2018)
122	Leye, Guangxi	4		57.7	23.4-88.9	Wang et al. (2012)
123	Zhejiang	100	Agricultural soil	158	303-490	Sun et al. (2017)
124	Changchun, Jilin	32	Agricultural soil	877.23	602.12-1271.87	Chen et al. (2017)
125	Beijing-Tianjin	180		1040.8	322.6-23244.7	Qiao et al. (2010)
126	Urumqi, Xinjiang	28		1742	331-15799	Chen et al. (2013)
127	Shenyang, Liaoning	74		2370	283-21821	Qing et al. (2019)
128	Taiyuan, Shaanxi	15		8740	1000-26000	Shan et al. (2010)
129	Zhengzhou, Henan	130		1567	49.9-11565	Zhang et al. (2020)
130	Harbin, Heilongjiang	17		508	17-3260	Ma et al. (2009)
131	Linfen, Shaanxi	10		9.8	1.1-63.7	Fu et al. (2009)

132	Bohai area, Shandong	31		310	66-920	Jiao et al. (2013)
133	Lishui, Jiangsu	74		10.95	3.26-91	Hu et al. (2009)
134	Anhui	33		840	130-3540	Wang et al. (2010)
135	Urumqi, Xinjiang	4	Agricultural soil	1742	/	Chen et al. (2015)
136	Lanzhou, Gansu	28		472.05	56.5-2707.2	Feng et al. (2020)
137	Yangzhou, Jiangsu	10	Agricultural soil	427	75-969	Yao et al. (2020)
138	Chongqing	21	Agricultural soil	750.4	277-3301	Lan et al. (2016)
139	Zhuzhou, Hunan	185	Agricultural soil	280	ND-5521	Zhang et al. (2009)
140	Fuzhou, Fujian	14	Agricultural soil	522.7	100.2-1215.1	Han et al. (2008)
141	Guiyang, Guizhou	14		537.6	61-1560	Hu et al. (2011)
142	Mianzhu, Sichuan	11		381.83	32.78-1131.57	Ke et al., (2013)
143	Yingchuan, Ningxia	37		190.6	/	Li et al. (2014)
144	Qiannan, Guizhou	98	Agricultural soil	58.64	40.6-475.36	Fang et al. (2014)
145	Huhehaote, Neimenggu	60	Agricultural soil	338	114-948	Zhang et al. (2017)
146	Qinghai	88		51.8	/	Tao et al. (2011)
147	Qinghai	55		267.97	40.47-1276.4	Tao et al. (2011)
148	Tibet	10		3.98	0.83-14.41	Sun et al. (2007)
149	Shanghai	24		1600	/	Du et al. (2014)
150	Xian, Shanxi	5		2727	125-9057	Zhou et al. (2012)

151	Zhanjiang, Guangdong	61		552.82	9.5-6618	Ma et al. (2012)
152	Suzhou, Jiangsu	96	Agricultural soil	312.5	45.4-3703	Liu et al. (2010)
153	Jiaxing, Zhejiang	324	Agricultural soil	152.4	9-2421	Liu et al. (2010)
154	Tianjin	210		932	58.2-9160	Shi et al. (2021)
155	Shanghai	41		339	17.2-3775	Yang et al. (2021)
156	Jilin	60		637.7	390.54-962.86	Chen et al. (2021)
157	Shandong	31		10100	9.4-261000	Xie et al. (2021)
158	Qinghai	89		318.37	169-638.94	Zhang et al. (2021)
159	Zhengzhou, Henan	130		1567	49.9-11565	Zhang et al. (2020)
160	Shenzhen, Guangdong	15		396.27	73.47-985.05	Chen et al. (2020)
161	Miyun, Beijing	48		215.39	68.27-503.08	Wu et al. (2020)
162	Guangzhou, Guangdong	24		490.68	296.26-888.14	Xie et al. (2020)
163	Laizhou, Shandong	22		134.46	60.5-303.48	Chen et al. (2020)
164	Jilin	28		487	306-5300	Wang et al. (2019)
165	Fenyang, Shaanxi	10	Agricultural soil	982.18	171.67-3176.79	Cui et al. (2015)
166	Dongguan, Guangdong	59	Agricultural soil	316.96	29-2184	Ma et al. (2011)
167	Qianan, Hebei	9	Agricultural soil	487.53	118.1-1042.31	Zhao et al. (2015)
168	Xian, Shanxi	17		591	362-1336	Zhou et al. (2017)
169	Nanjing, Jiangsu	29	Agricultural soil	226.64	24.49-750.04	Zhang et al. (2021)

170	Shanghai	42		3918.92	227.85-16461.75	Chen et al. (2020)
171	Lanzhou, Gansu	7		251.62	59.66-681.49	Feng et al. (2020)
172	Beijing	168		460.75	7.19-1811.99	Zhou et al. (2019)
173	Shandong	89		149.8	31.5-1399.4	Qiu et al. (2019)
174	Baise, Guangxi	11		1151.7	105.6-4751.4	Shi et al. (2014)
175	Taiyuan, Shanxi	15		8650	980-26230	Liu et al. (2008)
176	Shouguang, Shandong	39	Agricultural soil	289	84-1076	Feng et al. (2013)
177	Linfen, Shaanxi	128		723.2	/	Tao et al. (2016)
178	Liaohe, Liaoning	30		15.96	7.68-44.61	Guo et al. (2018)
179	Binhai, Tianjin	38		1148.1	68.7-5991.7	Li et al. (2008)
180	Yanji, Jilin	16		1626	598-4749	Wang et al. (2020)
181	Zhenjiang, Jiangsu	5		27.2	2.4-49.9	Wang et al. (2009)
182	Huaian, Jiangsu	9		1641	561-3421	Zhang et al. (2007)
183	Qiannan, Guizhou	98		56.8	3.7-259.6	Lin et al. (2015)
184	Qiannan, Guizhou	99		68.7	42.4-163.1	Chen et al. (2009)
185	Shenzhen, Guangdong	36		664.7	67.7-7137	Zhang et al. (2008)
186	Ataile, Xinjiang	14		32.24	3.48-103.81	Xu et al. (2021)
187	Yancheng, Jiangsu	30		3504.8	1212.8-12264.5	Yu et al. (2018)

188	Fushun, Liaoning	8		142.06	1.9-322.2	Xu et al. (2014)
189	Beijing	31		258.5	113.5-449.8	Li et al. (2017)
190	Gourong, Jiangsu	20		60.76	5.15-375.19	Wang et al. (2010)
191	Nanning, Guangxi	12		3351.3	2632-5002.43	Long et al. (2017)
192	Hangzhou, Zhejiang	20		1032.24	268.16-3304.6	Lin et al. (2015)
193	Shanbei, Shanxi	4	Agricultural soil	73.7	/	Li et al. (2011)
194	Jiulongjiang, Fujian	19		32.78	12.15-221.26	Liu et al. (2013)
195	Shenbei, Shenyang	9		291.1	/	Li et al. (2017)
196	Shenbei, Shenyang	21	Paddy soil	209.9	/	Li et al. (2017)
197	Shenbei, Shenyang	34		254.8	/	Li et al. (2017)
198	Liaohe, Liaoning	10		19.33	8.33-77.34	Mu et al. (2018)
199	Taiyuan, Shaanxi	7	Agricultural soil	210	78-325	Zhang et al. (2014)
200	Shandong	22		2564.7	21-20062	Li et al. (2017)
201	Huhehaote, Neimenggu	37		205	75.4-885	Zhou et al. (2013)
202	Tianjin	10		765	142-1490	Zhu et al. (2014)

203	Heilongjiang	59		675.99	131.93-1699.14	Hua et al. (2017)
204	Nanchong, Sichuan	6		366.87	89.5-616.9	Shi et al. (2010)
205	Bijie, Guizhou	29	Agricultural soil	1500	196-11592	Chen et al. (2017)
206	Nanchang, Jiangxi	18	Agricultural soil	384.7	145.4-695.3	Gong et al. (2010)
207	Jinzhong, Shaanxi	8	Agricultural soil	454.6	215-826.8	He et al. (2020)

Reference for Table S1

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Table S2 TEF of 16 PAHs

PAHs	TEF	PAHs	TEF
NAP	1E-03	BaA	0.1
ACY	1E-03	CHR	1E-02
ACE	1E-03	BbF	0.1
FL	1E-03	BkF	0.1
PHE	1E-03	BaP	1
ANT	1E-02	IND	0.1
FLU	1E-03	DBA	1
PYR	1E-03	BghiP	1E-02

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Table S3 Parameters used in the ILCR model

Parameter	Units	Adults	Children	Reference
BW (body weight)	kg	60	21	Wang, et al., (2007)
EF（exposure frequency）	d year^{-1}	350	350	USEPA, 2011
ED（exposure duration）	year	30	6	USEPA, 2011
IR_{Inh}（inhalation rate）	m^3 d^{-1}	20	7.6	Tong et al., (2018);Zheng, et al., (2019)
IR_{Ing}（soil intake rate）	mg d^{-1}	100	200	Tong et al., (2018);Zheng, et al., (2019)
SA（dermal surface exposure）	cm^2 d^{-1}	5700	2800	Tong et al., (2018);Zheng, et al., (2019)
AF（dermal adherence factor）	mg cm-^{2}	0.07	0.2	Tong et al., (2018);Zheng, et al., (2019)
ABS（dermal adsorption fraction）	unitless	0.13	0.13	Tong et al., (2018);Zheng, et al., (2019)
AT（average life span）	d	70×365	70×365	Tong et al., (2018);Zheng, et al., (2019)
PEF（particle emission factor）	m^3 kg^{-1}	1.36×10^9	1.36×10^9	Tong et al., (2018);Zheng, et al., (2019)
CSF_{ing}（carcinogenic slope factor for inhalation）	(mg kg^{-1} d^{-1})$^{-1}$	7.3	7.3	Knafla et al., (2006)
CSF_{derm}（carcinogenic slope factor for dermal contact）	(mg kg^{-1} d^{-1})$^{-1}$	25	25	Knafla et al., (2006)
CSF_{inh}（carcinogenic slope factor for inhalation）	(ug m^{-3})$^{-1}$	3.85	3.85	Knafla et al., (2006)

Reference for Table S3

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Table S4 Variable parameters used in the probabilistic risk assessment

	Parameter	Probabilistic Distribution	Parameters	Reference
Adults	*BW*	Lognormal (mean, SD)	LN (63.7, 12.6)	MEPC. 2013
	EF	Lognormal (mean, SD)	LN (54.1,109.8)	MEPC. 2013
	IR_{Inh}	Lognormal (mean, SD)	LN (16.57,4.05)	Chen et al., (2017)
	IR_{Ing}	Triangular (min, likeliest, max)	TRI (66,103,161)	MEPC. 2013
	SA	Triangular (min, likeliest, max)	TRI (0.076,0.153,0.382)	Li et al., (2014)
Children	*BW*	Lognormal (mean, SD)	LN (37.0, 2.98)	MEPC. 2013
	EF	Lognormal (mean, SD)	LN (54.1,109.8)	MEPC. 2013
	IR_{Inh}	Lognormal (mean, SD)	LN (7.19,1.62)	Chen et al.,(2017)
	IR_{Ing}	Triangular (min, likeliest, max)	TRI (4,30,52)	MEPC. 2013
	SA	Triangular (min, likeliest, max)	TRI (0.043,0.086,0.216)	Li et al., (2014)

SD: Standard deviation

Reference for Table S4

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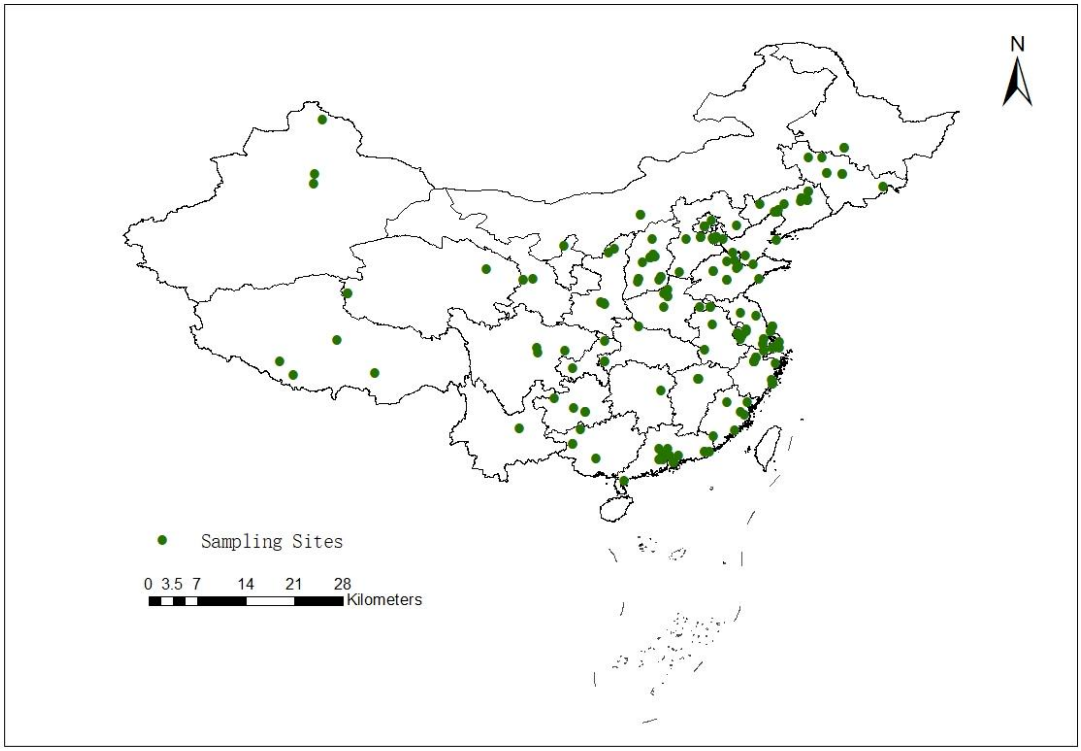

Fig. S1 The soil sampling sites of 207 investigated areas in 30 Provinces in China

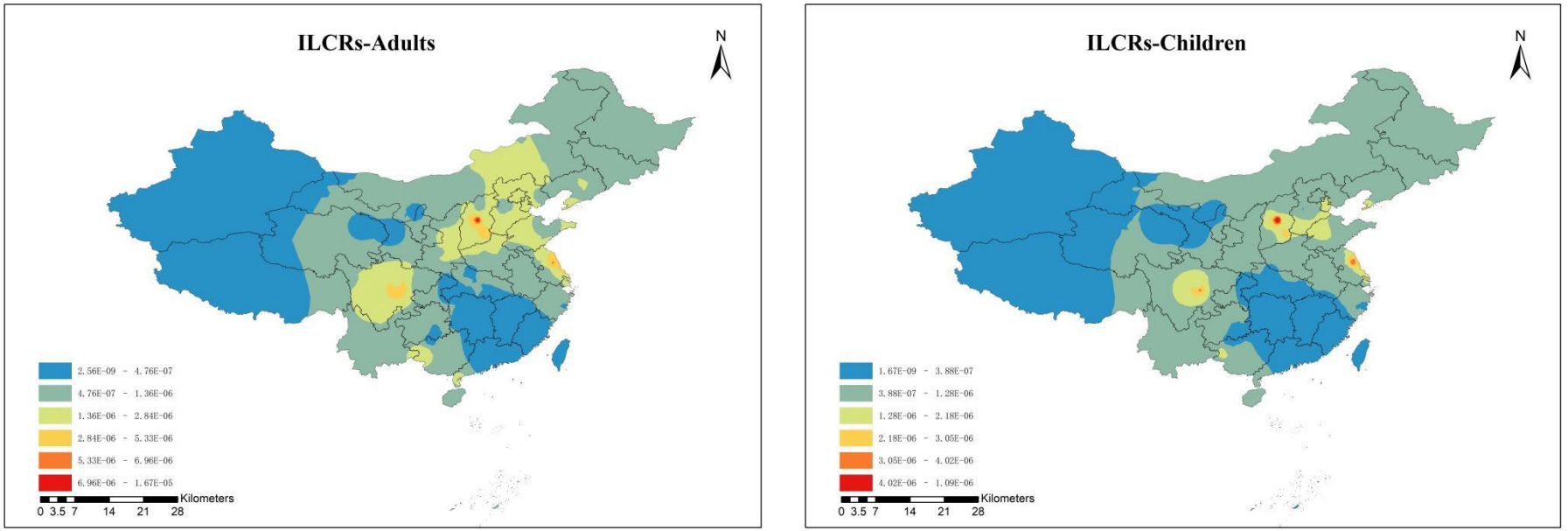

Fig. S2 The spatial distribution of *ILCRs* of adults and children

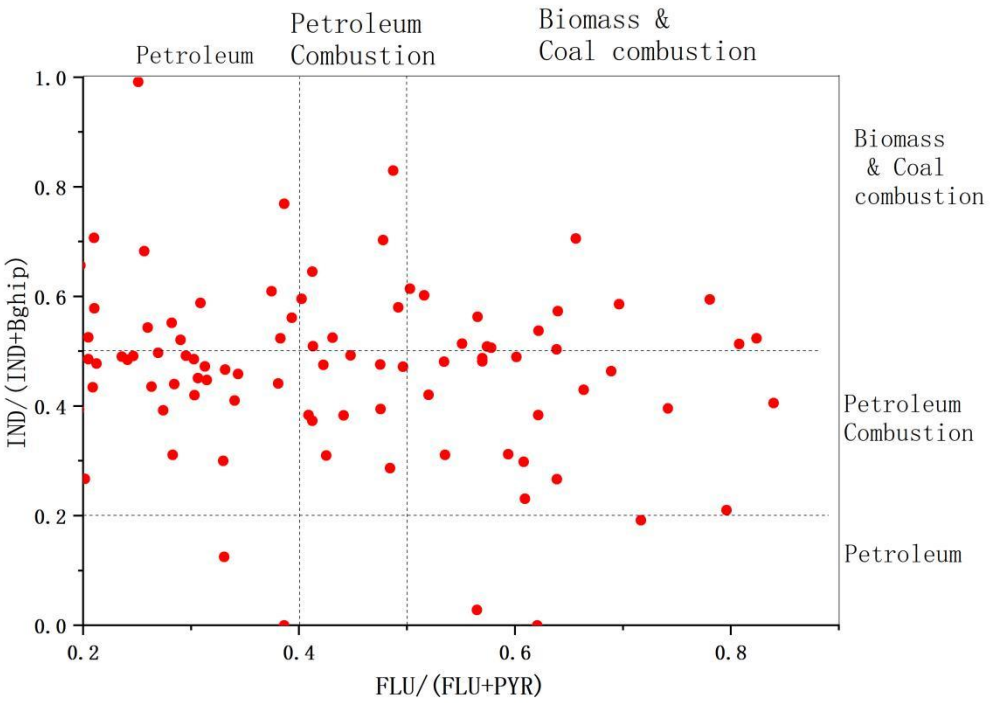

Fig. S3 Plot of IND/(IND+BghiP) vs. FLU/(FLU+PYR) for soil samples