

## Supplementary materials

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**Table S1.** Lists of cities of BTH, CYRD and PRD. (UA refers to urban agglomeration).

UA	Province	City	UA	Province	City	UA	Province	City
<b>BTH</b>	Beijing	Beijing	<b>CYRD</b>	Shanghai	Shanghai	<b>PRD</b>	Guangdong	Dongguan
	Tianjin	Tianjin		Anhui	Anqing			Foshan
		Chengde			Chizhou			Guangzhou
		Baoding			Chuzhou			Huizhou
		Zhangjiakou			Hefei			Jiangmen
		Qinhuangdao			Maanshan			Shenzhen
		Tangshan			Tongling			Zhaoqing
	Hebei	Langfang			Wuhu			Zhongshan
		Shijiazhuang			Xuancheng			Zhuhai
		Cangzhou		Jiangsu	Changzhou			
		Hengshui			Nanjing			
		Xingtai			Nantong			
		Handan			Suzhou			
					Taizhou			
					Wuxi			
					Yancheng			
					Yangzhou			
					Zhenjiang			
				Zhejiang	Hangzhou			
					Huzhou			
					Jiaxing			
					Jinhua			
					Ningbo			
					Shaoxing			
					Taizhou			
					Wenzhou			
					Zhoushan			

**Table S2.** Area and occupancy rate of EQI at various levels in core and expansion areas in 2001 and 2020 in three urban agglomerations.

BTH								
	BTH_2001_Core		BTH_2020_Core		BTH_2001_Expansion		BTH_2020_Expansion	
EQI level	Area	Percentage	Area	Percentage	Area	Percentage	Area	Percentage
Excellent	0	0	0	0	4	0.09	0	0
Good	20	0.61	2	0.06	738	16.96	6	0.14
Moderate	730	22.33	61	1.87	2335	53.67	543	12.48
Poor	2419	74.0	2532	77.45	1235	28.38	3509	80.65
Bad	100	3.06	674	20.62	39	0.90	293	6.73
CYRD								
	CYRD_2001_Core		CYRD_2020_Core		CYRD_2001_Expansion		CYRD_2020_Expansion	
EQI level	Area	Percentage	Area	Percentage	Area	Percentage	Area	Percentage
Excellent	1	0.02	1	0.02	43	0.36	4	0.03
Good	209	4.39	16	0.34	6455	53.67	124	1.03
Moderate	1814	38.14	472	9.92	4343	36.11	3914	32.55
Poor	2687	56.50	4193	88.16	1076	8.95	7872	65.45
Bad	45	0.95	74	1.56	110	0.91	113	0.94
PRD								
	PRD_2001_Core		PRD_2020_Core		PRD_2001_Expansion		PRD_2020_Expansion	
EQI level	Area	Percentage	Area	Percentage	Area	Percentage	Area	Percentage
Excellent	5	0.10	6	0.12	28	1.05	5	0.19
Good	284	5.49	144	2.78	601	22.49	131	4.90
Moderate	2633	50.85	1254	24.22	1689	63.21	1221	45.70
Poor	2255	43.56	3771	72.84	354	13.25	1305	48.84
Bad	0	0	2	0.04	0	0	10	0.37
Unit: Area(km <sup>2</sup> ), Percentage (%)								

**Table S3.** Result of intensity of urban expansion, EQI changes and USI of all cities in three urban agglomerations. (UEI, EQICI and USI mean the urban expansion intensity, EQI change intensity and urban synergistic index, respectively).

UA	City	UEI	EQICI	USI
BTH	Tianjin	3.251443552	-0.205437387	-0.063183439
	Xingtai	2.525739949	-0.042809255	-0.016949194
	Langfang	1.725408852	-0.199302496	-0.115510301
	Beijing	1.562325939	-0.121836333	-0.07798394
	Hengshui	1.460029137	-0.045026883	-0.030839715
	Cangzhou	1.416683418	-0.125667087	-0.08870513
	Chengde	1.411562135	-0.020617893	-0.014606437
	Baoding	1.307709004	-0.058315534	-0.044593663
	Handan	1.252975876	-0.068903748	-0.054992079
	Zhangjiakou	1.181267074	0.130162256	0.110188677
	Shijiazhuang	1.067140803	-0.084816349	-0.079479998
	Tangshan	0.937949067	-0.22336048	-0.238137109
	Qinhuangdao	0.930626391	-0.167707997	-0.180209801
CYRD	Chizhou	6.166978252	0.021659765	0.003512217
	Jiaxing	5.892229016	-0.148447789	-0.025193825
	Chuzhou	5.101239063	0.087836026	0.017218567
	Yangzhou	4.525641928	-0.047993326	-0.010604756
	Hangzhou	4.327494139	0.009229276	0.002132707
	Suzhou	4.294467929	-0.105721231	-0.024618005
	Xuancheng	4.166617911	-0.010236682	-0.002456832
	Huzhou	4.073088007	-0.079974708	-0.019634908
	Zhenjiang	3.896968116	-0.072289503	-0.018550191
	Taizhou	3.816615667	-0.124705437	-0.03267435
	Wuxi	3.376759575	-0.074652881	-0.022107846
	Hefei	3.372140924	0.029534413	0.008758357
	Yancheng	3.353712259	-0.023981225	-0.007150651
	Taizhou	3.125321084	0.032018018	0.010244713
	Nanjing	2.635668198	-0.083248368	-0.031585299
	Wuhu	2.632732054	-0.058238176	-0.022120814
	Anqing	2.58136841	-0.006232581	-0.002414448
	Tongling	2.512313912	-0.020135735	-0.008014817
	Nantong	2.432616572	-0.079581175	-0.032714229
	Changzhou	2.332602391	-0.101105671	-0.04334458
	Zhoushan	2.234760278	0.197563748	0.088404895
	Shaoxing	2.17873141	0.01293737	0.005938029
	Jinhua	2.107636662	0.017263212	0.008190791
	Ningbo	2.012381833	-0.012488163	-0.006205663

	Maanshan	1.855252431	-0.044514508	-0.023993774
	Shanghai	1.433636763	-0.046163001	-0.032199928
	Wenzhou	0.764265537	0.058861961	0.077017683
	Huizhou	4.777598719	0.003734096	0.000781584
	Zhongshan	2.471422989	-0.101423497	-0.041038502
	Zhuhai	2.191544228	-0.116607702	-0.053208008
	Zhaoqing	2.082756579	0.10399357	0.049930736
<b>PRD</b>	Jiangmen	1.934174056	0.030098958	0.01556166
	Guangzhou	1.744496692	-0.009704479	-0.00556291
	Foshan	1.613826971	-0.035162348	-0.021788177
	Shenzhen	1.583951159	0.000968488	0.000611438
	Dongguan	1.572168318	-0.093459263	-0.059446092

**Table S4.** Total area and land occupation rate of  $\Delta$ EQI at various levels of urban agglomerations.

	<b>BTH</b>		<b>CYRD</b>		<b>PRD</b>	
<b>EQI change</b>	<b>Area</b>	<b>Percentage</b>	<b>Area</b>	<b>Percentage</b>	<b>Area</b>	<b>Percentage</b>
<b>Obvious Improved (OI)</b>	1	0.00	155	0.07	2	0.00
<b>Slightly Improved (SI)</b>	8333	3.89	4523	2.09	3224	6.25
<b>Inapparent Change (IC)</b>	170177	79.41	160650	74.25	44121	85.50
<b>Slightly Deteriorated (SD)</b>	35106	16.38	49289	22.78	4209	8.15
<b>Deteriorated (DR)</b>	697	0.32	1754	0.81	53	0.10

Unit: Area(km<sup>2</sup>), Percentage (%)

**Table S5.** Results of collinearity diagnosis of single urban agglomeration. The number in gray font means insignificant result.

	<b>GDP</b>	<b>HD</b>	<b>LAI</b>	<b>Soil</b>	<b>Tmp</b>	<b>Pre</b>	<b>PM2.5</b>	<b>NDVI</b>	<b>GPP</b>	<b>LC</b>
<b>BTH</b>	1.572	1.321	6.272	1.127	2.041	3.418	5.073	3.118	6.306	2.238
<b>VIF</b> <b>CYRD</b>	2.068	1.329	7.575	1.204	1.874	1.720	3.376	6.221	5.339	2.514
<b>PRD</b>	2.584	1.478	11.137	1.233	2.174	1.297	1.919	7.347	18.576	2.611

**Table S6.** Global Moran' I measurement results of EQI in three urban agglomerations.

<b>UA</b>	<b>BTH</b>		<b>CYRD</b>		<b>PRD</b>	
	<b>2001</b>	<b>2020</b>	<b>2001</b>	<b>2020</b>	<b>2001</b>	<b>2020</b>
Moran' I	0.255632	0.291790	0.3088	0.1761	0.1985	0.1096
Z value	103.2438	145.3005	108.0048	183.9107	39.2330	52.5915
P value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000