



Supplementary materials

Table S1. Names and abbreviations of cities in the study region.

Municipalities or provinces	Abbr	Cities in Hebei Province	Abbr	Cities in Shanxi Province	Abbr	Cities in Shandong Province	Abbr	Cities in Henan Province	Abbr
Beijing City	BJ	Shijiazhuang city	SJZ	Taiyuan City	TY	Jinan City	JN	Zhengzhou City	ZZH
Tianjin City	TJ	Tangshan City	TS	Datong City	DT	Qingdao City	QD	Kaifeng City	KF
Hebei Province	Hebei	Qinhuangdao City	QHD	Yangquan City	YQ	Zibo City	ZB	Luoyang City	LYY
Shanxi Province	Shanxi	Handan City	HD	Changzhi City	CZZ	Zaozhuang City	ZZ	Pingdingshan City	PDS
Shandong Province	Shandong	Xingtai City	XT	Jincheng City	JC	Dongying City	DY	Anyang City	AY
Henan Province	Henan	Baoding City	BD	Shuozhou City	SZ	Yantai City	YT	Hebi City	HB
		Zhangjiakou City	ZJK	Jinzhong City	JZ	Weifang City	WF	Xinxiang City	XX
		Chengde City	CD	Yuncheng City	YC	Jining City	JNN	Jiaozuo City	JZ
		Cangzhou City	CZ	Xinzhou City	XZ	Taian City	TA	Puyang City	PY
		Langfang City	LF	Linfen City	LFF	Weihai City	WH	Xuchang City	XC
		Hangshui City	HS	Lvliang City	LL	Rizhao City	RZ	Luohe City	LH
						Linyi City	LY	Sanmenxia City	SMX
						Dezhou City	DZ	Nanyang City	NY
						Liaocheng City	LC	Shangqiu City	SQ
						Binzhou City	BZ	Xinyang City	XY
						Heze City	HZ	Zhoukou City	ZKD
								Zhumadian City	ZMD
								Jiyuan City	JY

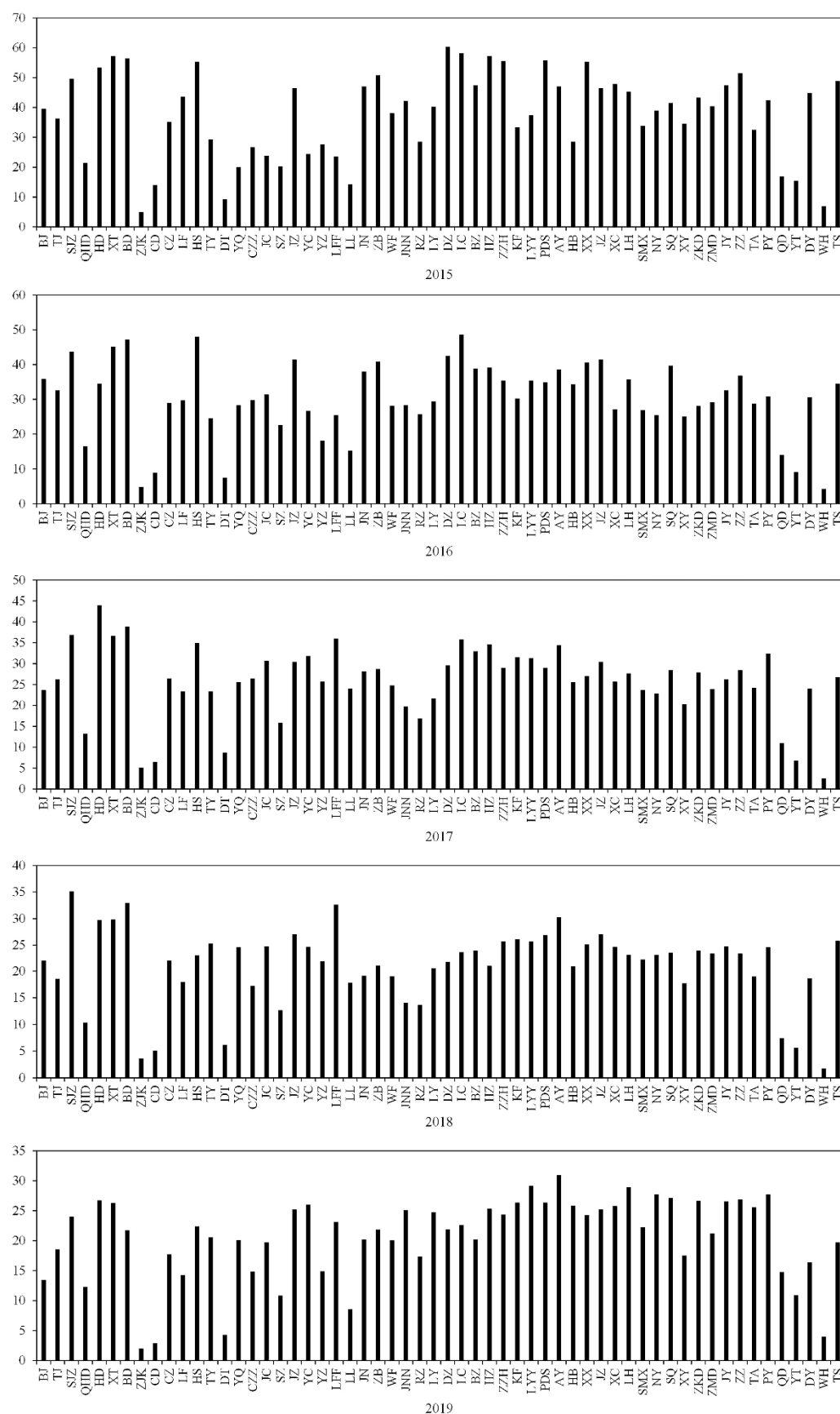


Figure S1. the percentage of exceeding standard days in each city from 2015 to 2019.

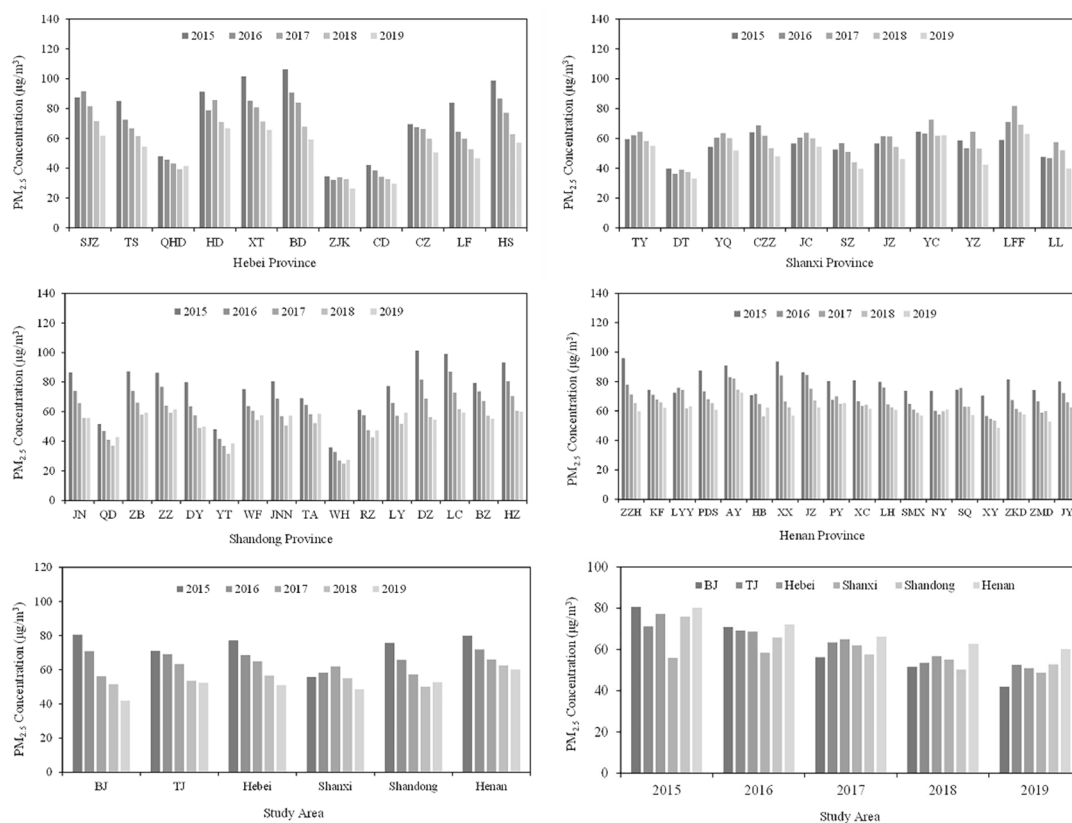


Figure S2. PM2.5 concentration in each city and province from 2015 to 2019.

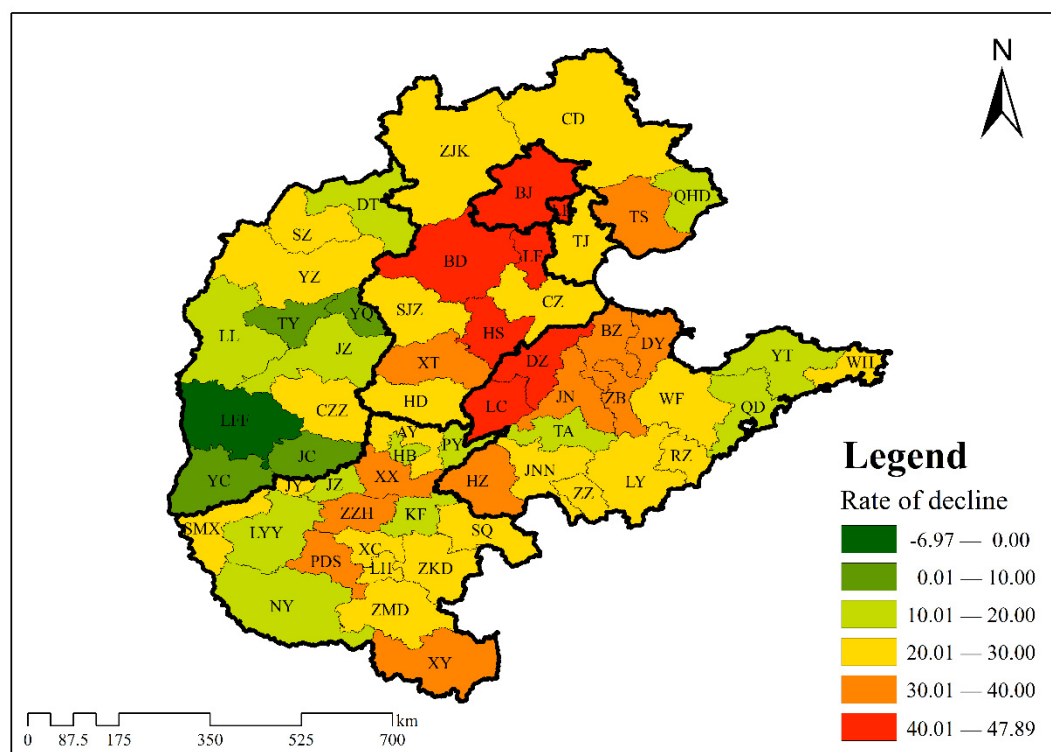


Figure S3. Decreasing rate of PM2.5 concentration in 2019 compared with 2015.

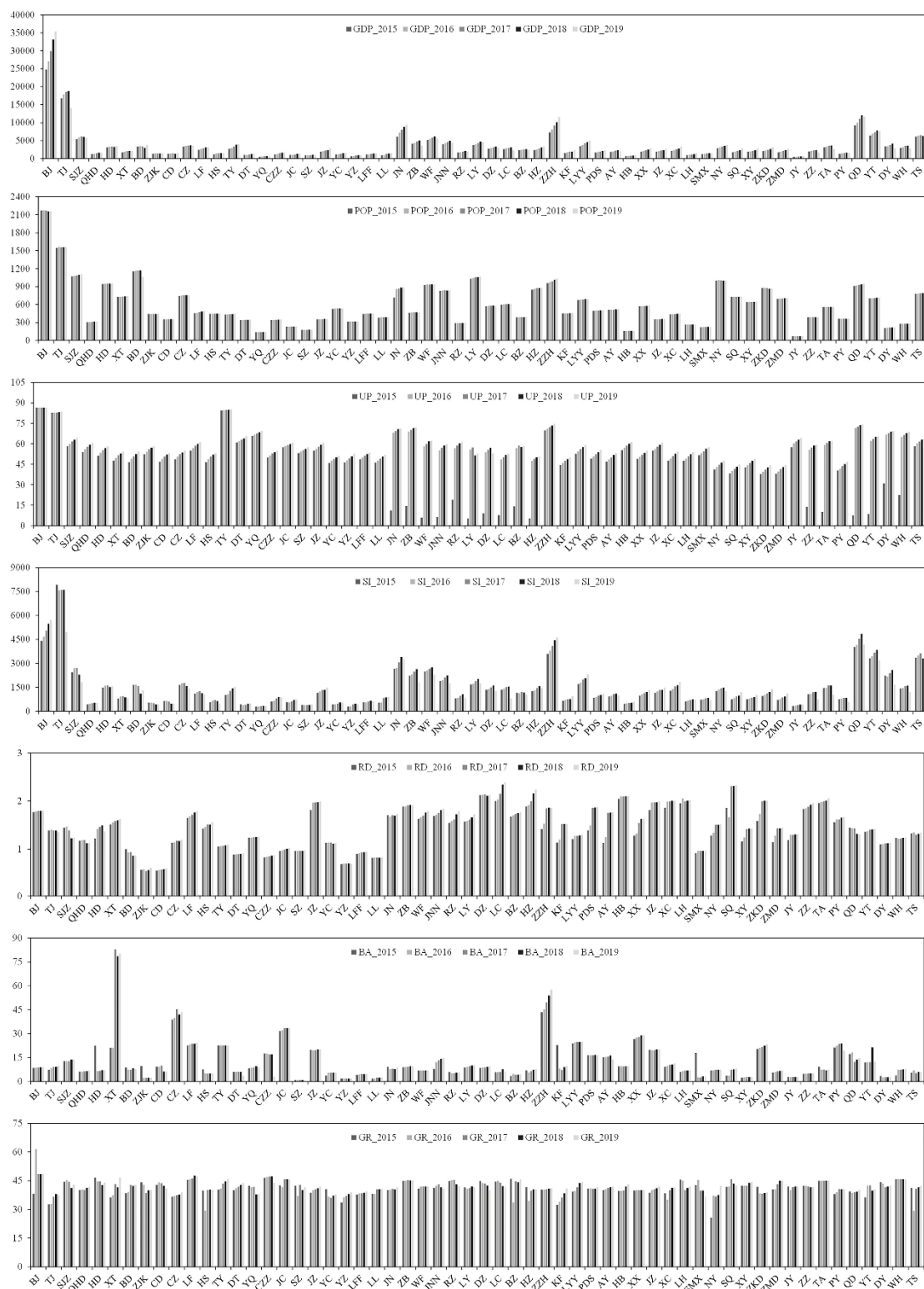


Figure S4. Statistics of social and economic factors in each city from 2015 to 2019.