## Supplementary Information

**Table S1.** Definition and values of formula parameters.

| Parameters | Definition | Units | Adults | Children |
|---|---|---|---|---|
| *c* | Concentration of contaminants in soil | mg/kg | Measured value, upper limit of the 95% confidence interval | |
| *OSIR* | Oral soil ingestion rate | mg/d | 100 | 200 |
| *DAIR* | Daily air ingestion rate | $m^3/d$ | 14.5 | 7.5 |
| *CF* | Conversion coefficient | kg/mg and $m^3/cm^3$ | 1.00E-06 | |
| *EF* | Exposure frequency | d/a | 350 | |
| *ED* | Exposure duration | a | 24 | 6 |
| *BW* | body weight | kg | 56.8 | 15.9 |
| *AT* | Average exposure time | d | Carcinogenic 26280; non-carcinogenic 2190 | |
| *SAE* | Skin Exposure Area | $cm^2$ | 5075 | 2448 |
| $PM_{10}$ | Content of inhalable particulates in ambient air | $mg/cm^3$ | 0.15 | |
| *SSAR* | Adherence rate of soil on skin | $mg/cm^2$ | 0.07 | 0.2 |
| *ABS* | Dermal absorption factor | - | 0.001 | |
| $E_v$ | Daily exposure frequency of dermal contact event | times/d | 1 | |
| *PIAF* | Retention fraction of inhaled particulates in body | -- | 0.75 | |
| *fspo* | Fraction of soil-borne particulates in outdoor air | - | 0.5 | |
| *fspi* | Fraction of soil-borne particulates in indoor air | - | 0.8 | |
| *EFO* | Outdoor exposure frequency | d/a | 87.5 | |
| *EFI* | Indoor exposure frequency | d/a | 262.5 | |

**Table S2.** Values of reference dose（RfD, mg $kg^{-1}$ $d^{-1}$）and slope factor (SF, mg $kg^{-1}$ $d^{-1}$) for elements.

| Eements | *RfD* /(mg $kg^{-1}$ $d^{-1}$) | | | *SF* /(kg d $mg^{-1}$) | | |
|---|---|---|---|---|---|---|
| | ingestion | inhalation | dermal contact | ingestion | inhalation | dermal contact |
| Hg | $3 \times 10^{-5}$ | $2.1 \times 10^{-5}$ | $7.66 \times 10^{-5}$ | - | - | - |
| Cu | $4 \times 10^{-2}$ | $1.2 \times 10^{-2}$ | $4 \times 10^{-2}$ | - | - | - |
| Zn | 0.3 | 0.3 | 0.3 | - | - | - |
| Pb | $3.5 \times 10^{-3}$ | $5.25 \times 10^{-4}$ | $3.52 \times 10^{-3}$ | $8.5 \times 10^{-3}$ | - | - |

The distribution of soil pH and SOM in the study area shows significant spatial differentiation: The soil is generally alkaline, and the high-value areas with pH>8 are concentrated in coal mines, coal gangue yards and industrial areas (such as S20 and S24), which may be related to the discharge of industrial alkaline pollutants (Figure S2). Neutral to weakly alkaline areas (pH 7-7.5) are widely distributed around town and along the banks of the Huihe River, while sporadic acidic points (pH<7) occur near the Huihe River (such as S41 and S42), which may be affected by river alluvial action. The overall content of SOM was relatively low (<20 $mg \cdot kg^{-1}$), and the high-value areas (>30 $mg \cdot kg^{-1}$) were concentrated in the agricultural areas (such as S27 and S22), which was related to farmland fertilization and vegetation coverage. However, SOM was extremely low in the coal mining areas (such as S24) and industrial areas (<10 $mg \cdot kg^{-1}$), reflecting soil impoverication. pH shows a negative correlation trend with SOM. However, due to agricultural

management, a synergistic feature of neutral pH and medium SOM is presented, indicating that human activities (industrial destruction, agricultural improvement) and natural geographical elements (river action) jointly shape the spatial pattern of the soil environment.

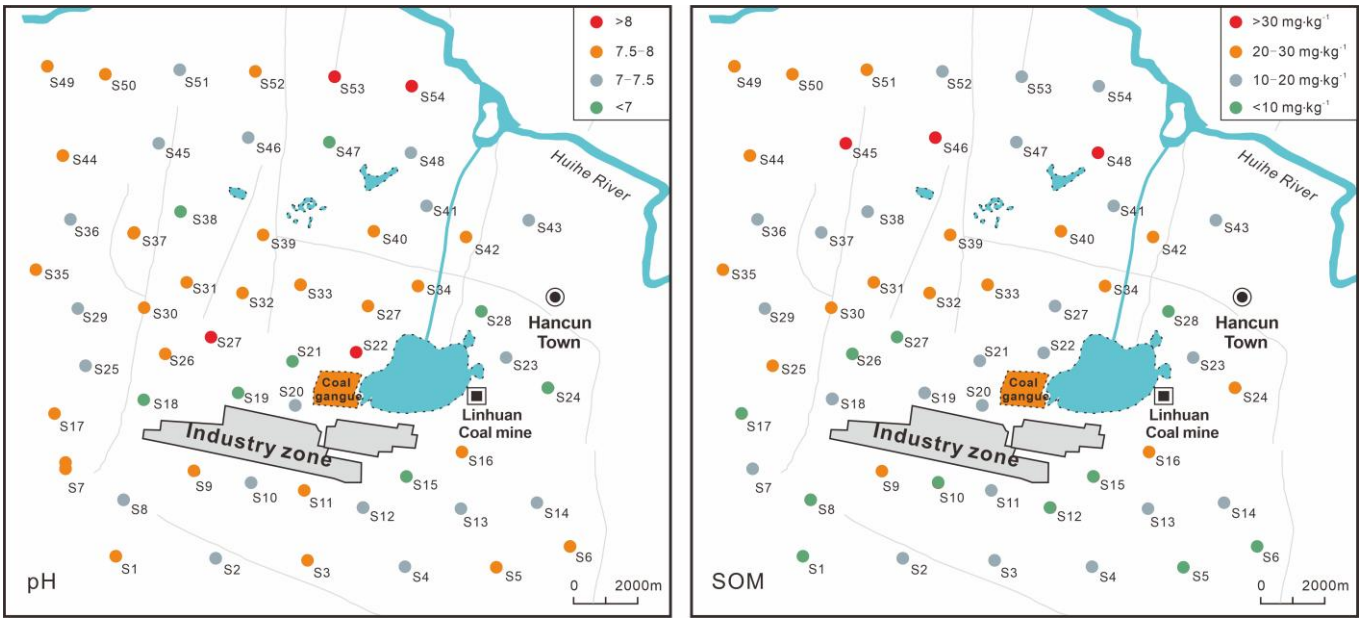


**Figure S1.** The spatial distribution of pH and SOM of soil in the study area.