***Supplementary Material***

1. **Supplementary Tables**

## Table S1.

Weather conditions in the month before sampling.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Date | Temperature (℃) | | Weather | Wind direction |
| Maximum | Minimum |
| 2024/6/5 | 26 | 18 | Overcast | Southeast Wind |
| 2024/6/6 | 29 | 21 | Rain | East Wind |
| 2024/6/7 | 25 | 20 | Rain | Southwest Wind |
| 2024/6/8 | 23 | 20 | Rain | Southwest Wind |
| 2024/6/9 | 26 | 20 | Rain | West Wind |
| 2024/6/10 | 29 | 20 | Cloudy | West Wind |
| 2024/6/11 | 25 | 21 | Overcast | West Wind |
| 2024/6/12 | 31 | 20 | Cloudy | East Wind |
| 2024/6/13 | 31 | 22 | Cloudy | North Wind |
| 2024/6/14 | 34 | 23 | Cloudy | West Wind |
| 2024/6/15 | 35 | 24 | Sunny | Southeast Wind |
| 2024/6/16 | 30 | 23 | Rain | Southeast Wind |
| 2024/6/17 | 30 | 21 | Cloudy | East Wind |
| 2024/6/18 | 30 | 22 | Rain | North Wind |
| 2024/6/19 | 26 | 22 | Rain | North Wind |
| 2024/6/20 | 29 | 22 | Rain | East Wind |
| 2024/6/21 | 29 | 23 | Rain | West Wind |
| 2024/6/22 | 29 | 24 | Cloudy | Southwest Wind |
| 2024/6/23 | 30 | 22 | Rain | South Wind |
| 2024/6/24 | 25 | 19 | Overcast | South Wind |
| 2024/6/25 | 27 | 20 | Overcast | East Wind |
| 2024/6/26 | 24 | 20 | Rain | East Wind |
| 2024/6/27 | 24 | 20 | Rain | East Wind |
| 2024/6/28 | 26 | 20 | Rain | South Wind |
| 2024/6/29 | 30 | 21 | Overcast | Southwest Wind |
| 2024/6/30 | 32 | 23 | Rain | East Wind |
| 2024/7/1 | 28 | 22 | Rain | West Wind |
| 2024/7/2 | 32 | 22 | Cloudy | Southeast Wind |
| 2024/7/3 | 30 | 24 | Rain | Northwest Wind |
| 2024/7/4 | 31 | 23 | Rain | North Wind |
| 2024/7/5 | 29 | 23 | Rain | West Wind |

Note: The meteorological data were obtained from the China Meteorological Administration (https://www.weather.com.cn/).

## Table S2.

Indicators, methods and detection limits for samples.

|  |  |  |
| --- | --- | --- |
| Analyte | Analytical Method & Instrument | Detection Limit (mg/kg) |
| pH | pH Meter (PHS-3C) | / |
| Pb | Graphite Furnace Atomic Absorption Spectroscopy (AA-240Z) | 0.1 |
| Cd | 0.01 |
| As | Atomic Fluorescence Spectroscopy  (AFS-8530) | 0.01 |
| Hg | 0.002 |

## Table S3.

Geo-accumulation index (Muller, 1969; Shen et al., 2024).

|  |  |  |
| --- | --- | --- |
| No. Class | Igeo Value | Contamination Level |
| 1 | Igeo ≤ 0 | Practically uncontaminated |
| 2 | 0 < Igeo ≤ 1 | Uncontaminated to moderately contaminated |
| 3 | 1 < Igeo ≤ 2 | Moderately contaminated |
| 4 | 2 < Igeo ≤ 3 | Moderately to strongly contaminated |
| 5 | 3 < Igeo ≤ 4 | Strongly contaminated |
| 6 | 4 < Igeo ≤ 5 | Strongly to extremely contaminated |
| 7 | Igeo ≥ 5 | Extremely contaminated |

## Table S4.

The range of TEC and PEC values (Macdonald et al., 1996).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | As | Cd | Pb | Hg |
| TEL/(mg·kg-1) | 7.24 | 0.68 | 30.2 | 0.13 |
| PEL/(mg·kg-1) | 41.60 | 4.21 | 112 | 0.70 |

## Table S5.

Potential Ecological Risk Factor , Risk Index (RI), and Ecological Risk Level (Hakanson, 1980; Lin et al., 2016).

|  |  |  |  |
| --- | --- | --- | --- |
| Potential Ecological Risk Index | Ecological Risk Level | Comprehensive Potential Ecological Risk Index, RI | Ecological Risk Level |
| < 40 | Slight ecological risk | RI < 150 | Slight ecological risk |
| 40 < ≤ 80 | Moderate ecological risk | 150 < RI < 300 | Moderate ecological risk |
| 80 < 160 | Strong ecological risk | 300 < RI < 600 | Strong ecological risk |
| 160 < 320 | Very strong ecological risk | RI ≥ 600 | Very strong ecological risk |
|  | Extremely strong ecological risk |  |  |

## Table S6.

The run parameters of PMF model.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Species | Category | S/N | Min | 25th | Median | 75th | Max | Modeled  sample | Raw  sample |
| As | Strong | 8.87 | 0.87 | 1.91 | 3.10 | 4.98 | 12.00 | 100.00 % | 100.00 % |
| Cd | Strong | 7.62 | 0.02 | 0.17 | 0.22 | 0.30 | 0.71 | 100.00 % | 100.00 % |
| Pb | Strong | 8.84 | 5.20 | 18.95 | 22.40 | 27.55 | 55.10 | 100.00 % | 100.00 % |
| Hg | Strong | 8.05 | 0.03 | 0.05 | 0.06 | 0.09 | 0.79 | 100.00 % | 100.00 % |

Note: S/N, Signal to Noise Ratio; SE, Standard Error.

## Table S7.

Regression diagnostics parameters obtained from Fpeak run.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Species | Intercept | Slope | SE | R2 | KS Test Stat | KS Test P Value |
| As | 0.22 | 0.93 | 0.48 | 0.95 | 0.12 | 0.16 |
| Cd | 0.01 | 0.93 | 0.02 | 0.97 | 0.07 | 0.74 |
| Pb | 2.14 | 0.88 | 3.70 | 0.80 | 0.11 | 0.25 |
| Hg | 0.06 | 0.10 | 0.03 | 0.11 | 0.15 | 0.04 |

Note: SE, Standard Error.

## Table S8.

Mapping of bootstrap factors to base factors

|  |  |  |  |
| --- | --- | --- | --- |
|  | Factor 1 | Factor 2 | Factor 3 |
| Boot Factor 1 | 100 | 0 | 0 |
| Boot Factor 2 | 0 | 100 | 0 |
| Boot Factor 3 | 0 | 0 | 100 |

## Table S9.

Fpeak run summary table.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Fpeak | Strength | dQ (Robust) | Q (Robust) | Q (True) | Converged |
| 1 | 0.5 | 184.7 | 722.5 | 668.2 | Yes |
| **2** | **-0.5** | **72.5** | **610.3** | **670.2** | **Yes** |
| 3 | 1.0 | 847.5 | 1385.3 | 677.6 | Yes |
| 4 | -1.0 | 240.6 | 778.4 | 677.4 | Yes |
| 5 | 1.5 | 2295.4 | 2833.2 | 696.1 | Yes |

## Table S10.

Source apportionment results are based on the PMF model.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Factor 1 | Factor 2 | Factor 3 |
| As | **71.72** | 0.00 | 28.28 |
| Cd | 28.94 | **70.92** | 0.14 |
| Pb | 6.72 | **47.87** | 45.41 |
| Hg | 26.38 | 19.72 | **53.90** |
| Source contributions (%) | 33.44 | 34.63 | 31.93 |

## Table S11.

Statistical characteristics of heavy metal contents in Study area (mg/kg), BSS represented the background value of stream sediments in China (Shi et al., 2016).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | pH | Pb | Cd | As | Hg |
| Kulong River  n = 9 | Min | 7.82 | 19.40 | 0.15 | 2.02 | 0.04 |
| Max | 8.34 | 39.00 | 0.53 | 6.33 | 0.10 |
| Mean | 8.09 | 28.53 | 0.27 | 4.60 | 0.07 |
| SD | 0.18 | 6.15 | 0.12 | 1.44 | 0.02 |
| Jiuqu River  n = 3 | Min | 7.36 | 21.60 | 0.14 | 0.90 | 0.03 |
| Max | 8.12 | 28.10 | 0.35 | 1.95 | 0.05 |
| Mean | 7.82 | 24.80 | 0.21 | 1.55 | 0.04 |
| SD | 0.40 | 3.25 | 0.12 | 0.57 | 0.01 |
| Zhuxi River  n = 8 | Min | 7.46 | 21.90 | 0.12 | 1.18 | 0.04 |
| Max | 8.27 | 30.50 | 0.37 | 2.18 | 0.06 |
| Mean | 7.90 | 25.93 | 0.24 | 1.80 | 0.05 |
| SD | 0.28 | 3.81 | 0.09 | 0.40 | 0.01 |
| Laixi Rvier  n = 8 | Min | 6.55 | 15.80 | 0.02 | 3.00 | 0.05 |
| Max | 8.76 | 31.20 | 0.71 | 8.10 | 0.79 |
| Mean | 7.77 | 22.25 | 0.25 | 4.55 | 0.19 |
| SD | 0.63 | 5.04 | 0.21 | 1.76 | 0.25 |
| Luojia River  n = 5 | Min | 6.90 | 17.60 | 0.12 | 0.87 | 0.03 |
| Max | 7.60 | 26.00 | 0.33 | 1.68 | 0.29 |
| Mean | 7.32 | 21.54 | 0.19 | 1.25 | 0.09 |
| SD | 0.29 | 3.78 | 0.08 | 0.33 | 0.11 |
| Taiping River  n = 11 | Min | 6.64 | 21.40 | 0.17 | 1.52 | 0.05 |
| Max | 8.39 | 50.70 | 0.37 | 6.63 | 0.26 |
| Mean | 7.74 | 28.29 | 0.25 | 3.47 | 0.10 |
| SD | 0.55 | 8.44 | 0.07 | 1.82 | 0.06 |
| Hongqi River  n = 5 | Min | 7.09 | 15.40 | 0.14 | 1.25 | 0.04 |
| Max | 8.21 | 49.30 | 0.39 | 1.92 | 0.21 |
| Mean | 7.70 | 26.90 | 0.23 | 1.54 | 0.09 |
| SD | 0.46 | 13.00 | 0.10 | 0.28 | 0.07 |
| Xiaoan River  n = 6 | Min | 6.68 | 16.30 | 0.13 | 1.23 | 0.04 |
| Max | 8.68 | 23.10 | 0.23 | 3.51 | 0.10 |
| Mean | 7.47 | 19.45 | 0.19 | 1.94 | 0.06 |
| SD | 0.84 | 3.26 | 0.04 | 0.85 | 0.02 |
| Huaiyuan River  n = 21 | Min | 7.09 | 10.00 | 0.12 | 1.90 | 0.04 |
| Max | 8.68 | 55.10 | 0.43 | 12.00 | 0.19 |
| Mean | 8.01 | 22.59 | 0.26 | 5.43 | 0.08 |
| SD | 0.45 | 9.93 | 0.07 | 2.61 | 0.04 |
| Ciba River  n = 3 | Min | 7.90 | 6.60 | 0.22 | 3.35 | 0.03 |
| Max | 8.03 | 28.70 | 0.36 | 9.80 | 0.12 |
| Mean | 7.98 | 18.67 | 0.27 | 6.12 | 0.07 |
| SD | 0.07 | 11.19 | 0.08 | 3.32 | 0.05 |
| Yongxi River  n = 8 | Min | 7.61 | 5.20 | 0.12 | 2.30 | 0.03 |
| Max | 8.39 | 22.90 | 0.36 | 4.12 | 0.19 |
| Mean | 7.98 | 15.81 | 0.23 | 3.00 | 0.08 |
| SD | 0.27 | 5.95 | 0.09 | 0.58 | 0.05 |
| Study Area  n = 85 | Min | 6.55 | 5.20 | 0.02 | 0.87 | 0.03 |
| Max | 8.76 | 55.10 | 0.71 | 12.00 | 0.79 |
| Mean | 7.84 | 23.43 | 0.24 | 3.69 | 0.09 |
| SD | 0.49 | 8.32 | 0.10 | 2.30 | 0.09 |
| BSS |  | / | 23.00 | 0.13 | 9.00 | 0.03 |

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