Table S.1: Exposure factors used in estimation of chronic daily intake (CDI) for non-carcinogenic risk (IARC, 2012; Miletic et al., 2023).

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Units** | **Adults** | **Children** |
| IngR | mg/day | 100 | 200 |
| InhR | m3/day | 20 | 7.6 |
| EF | days/year | 350 | 350 |
| ED | year | 24 | 6 |
| BW | Kg | 70 | 15 |
| ATnc | days | 8760 | 2190 |
| ATc | days | 25550 | 25550 |
| PEF | m3/Kg | 1.36×109 | 1.36×109 |
| SA | cm2 | 5700 | 2800 |
| AF | mg/cm | 0.07 | 0.2 |
| ABS | - | 0.001 | 0.001 |
| CF | Kg/mg | 10-6 | 10-6 |
| C | Mg/kg | - | - |

Table S.2: The reference dose (RfD) and the cancer slope factors (CSF) for HMs (IRIS, 2020; Miletic et al., 2023).

|  |  |  |  |
| --- | --- | --- | --- |
| **RfDinh** | **RfDderm** | **RfDing** | **HMs** |
| 2.06 × 10-2 | 5.4 × 10-3 | 2 × 10-2 | Ni |
| - | - | 7 × 10-1 | Fe |
| 3 × 10-1 | 6 × 10-2 | 3 × 10-1 | Zn |
| 3.52 × 10-3 | 3.25 × 10-4 | 3.5 × 10-3 | Pb |
| 3 × 10-4 | 1.23 × 10-4 | 3 × 10-4 | As |
| **CSFinh** | **CSFderm** | **CSFing** | **HMs** |
| 15.1 | 3.66 | 1.5 | As |
| 0.042 | - | 0.0085 | Pb |

Table S. 3: Concentration of HMs (mg/kg) in Al Majma’ah soil.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S.N. | Latitudes | Longitudes | As | Fe | Ni | Pb | Zn | PLI |
| S 1 | 25°52′213 | 45°17′256 | 2.00 | 8800 | 10.00 | 3.00 | 17.00 | 0.10 |
| S 2 | 25°51′813 | 45°17′185 | 7.00 | 40400 | 34.00 | 8.00 | 34.00 | 0.38 |
| S 3 | 25°52′061 | 45°17′311 | 4.00 | 14000 | 30.00 | 5.00 | 26.00 | 0.23 |
| S 4 | 25°53′251 | 45°18′241 | 4.00 | 33300 | 33.00 | 6.00 | 42.00 | 0.34 |
| S 5 | 25°53′527 | 45°18′548 | 1.50 | 9600 | 14.00 | 3.00 | 52.00 | 0.15 |
| S 6 | 25°53′553 | 45°18′331 | 1.50 | 19200 | 15.00 | 2.00 | 55.00 | 0.16 |
| S 7 | 25°53′789 | 45°17′979 | 7.00 | 24500 | 47.00 | 8.00 | 57.00 | 0.42 |
| S 8 | 25°53′830 | 45°19′288 | 6.00 | 28200 | 42.00 | 8.00 | 50.00 | 0.39 |
| S 9 | 25°53′802 | 45°19′427 | 5.00 | 20300 | 39.00 | 8.00 | 72.00 | 0.37 |
| S 10 | 25°53′823 | 45°19′556 | 7.00 | 29800 | 59.00 | 11.00 | 71.00 | 0.52 |
| S 11 | 25°54′415 | 45°19′892 | 6.00 | 23800 | 50.00 | 13.00 | 65.00 | 0.45 |
| S 12 | 25°54′607 | 45°19′609 | 6.00 | 27700 | 56.00 | 11.00 | 72.00 | 0.49 |
| S 13 | 25°55′310 | 45°18′771 | 5.00 | 25700 | 48.00 | 11.00 | 55.00 | 0.41 |
| S 14 | 25°55′421 | 45°18′644 | 7.00 | 27400 | 54.00 | 13.00 | 59.00 | 0.48 |
| S 15 | 25°55′246 | 45°20′059 | 4.00 | 17400 | 29.00 | 6.00 | 36.00 | 0.27 |
| S 16 | 25°54′618 | 45°20′549 | 4.00 | 22100 | 38.00 | 8.00 | 66.00 | 0.36 |
| S 17 | 25°54′988 | 45°20′601 | 4.00 | 18300 | 29.00 | 7.00 | 34.00 | 0.28 |
| S 18 | 25°55′276 | 45°20′637 | 6.00 | 25500 | 52.00 | 11.00 | 65.00 | 0.46 |
| S 19 | 25°55′246 | 45°20′549 | 5.00 | 22400 | 48.00 | 10.00 | 54.00 | 0.40 |
| S 20 | 25°55′275 | 45°20′342 | 4.00 | 15500 | 14.00 | 4.00 | 16.00 | 0.17 |
| S 21 | 25°55′483 | 45°20′352 | 5.00 | 20800 | 29.00 | 7.00 | 37.00 | 0.29 |
| S 22 | 25°58′864 | 45°19′550 | 3.00 | 15800 | 23.00 | 5.00 | 37.00 | 0.22 |
| S 23 | 25°59′301 | 45°19′411 | 3.00 | 11600 | 18.00 | 4.00 | 23.00 | 0.17 |
| S 24 | 25°59′197 | 45°18′640 | 3.00 | 18000 | 25.00 | 4.00 | 37.00 | 0.22 |
| S 25 | 25°58′974 | 45°19′052 | 4.00 | 12200 | 23.00 | 4.00 | 43.00 | 0.21 |
| S 26 | 25°59′628 | 45°18′499 | 3.00 | 12900 | 23.00 | 4.00 | 24.00 | 0.19 |
| S 27 | 25°59′671 | 45°18′386 | 3.00 | 12400 | 23.00 | 4.00 | 26.00 | 0.20 |
| S 28 | 26°00′648 | 45°18′772 | 3.00 | 12900 | 24.00 | 5.00 | 32.00 | 0.21 |
| S 29 | 26°00′386 | 45°19′365 | 2.00 | 7800 | 11.00 | 3.00 | 12.00 | 0.11 |
| S 30 | 25°00′061 | 45°19′526 | 2.00 | 12100 | 17.00 | 4.00 | 22.00 | 0.16 |
| S 31 | 25°03′551 | 45°20′626 | 3.00 | 13500 | 25.00 | 4.00 | 22.00 | 0.19 |
| S 32 | 26°03′375 | 45°20′116 | 3.00 | 12400 | 24.00 | 5.00 | 35.00 | 0.21 |
| S 33 | 26°03′227 | 45°19′865 | 2.00 | 9900 | 18.00 | 4.00 | 26.00 | 0.16 |
| S 34 | 25°03′870 | 45°21′296 | 3.00 | 13500 | 27.00 | 5.00 | 27.00 | 0.22 |
| Min. | 1.50 | 7800 | 10.00 | 2.00 | 12.00 | 0.10 |
| Max. | 7.00 | 40400 | 59.00 | 13.00 | 72.00 | 0.52 |
| Aver. | 4.07 | 19108 | 31.11 | 6.47 | 41.25 | 0.28 |

Table S. 4. Results of contamination factor (CF) and pollution load index (PLI) in Al Majma’ah soil.

|  |  |  |
| --- | --- | --- |
| S.N. | CF | PLI |
| As | Fe | Ni | Pb | Zn |
| S 1 | 0.15 | 0.19 | 0.15 | 0.15 | 0.18 | 0.10 |
| S 2 | 0.54 | 0.86 | 0.50 | 0.40 | 0.36 | 0.38 |
| S 3 | 0.31 | 0.30 | 0.44 | 0.25 | 0.27 | 0.23 |
| S 4 | 0.31 | 0.71 | 0.49 | 0.30 | 0.44 | 0.34 |
| S 5 | 0.12 | 0.20 | 0.21 | 0.15 | 0.55 | 0.15 |
| S 6 | 0.12 | 0.41 | 0.22 | 0.10 | 0.58 | 0.16 |
| S 7 | 0.54 | 0.52 | 0.69 | 0.40 | 0.60 | 0.42 |
| S 8 | 0.46 | 0.60 | 0.62 | 0.40 | 0.53 | 0.39 |
| S 9 | 0.38 | 0.43 | 0.57 | 0.40 | 0.76 | 0.37 |
| S 10 | 0.54 | 0.63 | 0.87 | 0.55 | 0.75 | 0.52 |
| S 11 | 0.46 | 0.50 | 0.74 | 0.65 | 0.68 | 0.45 |
| S 12 | 0.46 | 0.59 | 0.82 | 0.55 | 0.76 | 0.49 |
| S 13 | 0.38 | 0.54 | 0.71 | 0.55 | 0.58 | 0.41 |
| S 14 | 0.54 | 0.58 | 0.79 | 0.65 | 0.62 | 0.48 |
| S 15 | 0.31 | 0.37 | 0.43 | 0.30 | 0.38 | 0.27 |
| S 16 | 0.31 | 0.47 | 0.56 | 0.40 | 0.69 | 0.36 |
| S 17 | 0.31 | 0.39 | 0.43 | 0.35 | 0.36 | 0.28 |
| S 18 | 0.46 | 0.54 | 0.76 | 0.55 | 0.68 | 0.46 |
| S 19 | 0.38 | 0.47 | 0.71 | 0.50 | 0.57 | 0.40 |
| S 20 | 0.31 | 0.33 | 0.21 | 0.20 | 0.17 | 0.17 |
| S 21 | 0.38 | 0.44 | 0.43 | 0.35 | 0.39 | 0.29 |
| S 22 | 0.23 | 0.33 | 0.34 | 0.25 | 0.39 | 0.22 |
| S 23 | 0.23 | 0.25 | 0.26 | 0.20 | 0.24 | 0.17 |
| S 24 | 0.23 | 0.38 | 0.37 | 0.20 | 0.39 | 0.22 |
| S 25 | 0.31 | 0.26 | 0.34 | 0.20 | 0.45 | 0.21 |
| S 26 | 0.23 | 0.27 | 0.34 | 0.20 | 0.25 | 0.19 |
| S 27 | 0.23 | 0.26 | 0.34 | 0.20 | 0.27 | 0.20 |
| S 28 | 0.23 | 0.27 | 0.35 | 0.25 | 0.34 | 0.21 |
| S 29 | 0.15 | 0.17 | 0.16 | 0.15 | 0.13 | 0.11 |
| S 30 | 0.15 | 0.26 | 0.25 | 0.20 | 0.23 | 0.16 |
| S 31 | 0.23 | 0.29 | 0.37 | 0.20 | 0.23 | 0.19 |
| S 32 | 0.23 | 0.26 | 0.35 | 0.25 | 0.37 | 0.21 |
| S 33 | 0.15 | 0.21 | 0.26 | 0.20 | 0.27 | 0.16 |
| S 34 | 0.23 | 0.29 | 0.40 | 0.25 | 0.28 | 0.22 |

Table S. 5. HI values for the non-carcinogenic risks associated with HMs for both adults and children.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S.N. | As | Pb | Ni | Zn | Fe |
| Adults | Children | Adults | Children | Adults | Children | Adults | Children | Adults | Children |
| S1 | 0.009 | 0.085 | 0.001 | 0.011 | 0.001 | 0.006 | 0.0001 | 0.001 | 0.02 | 0.16 |
| S2 | 0.032 | 0.299 | 0.003 | 0.029 | 0.002 | 0.022 | 0.0002 | 0.001 | 0.08 | 0.74 |
| S3 | 0.018 | 0.171 | 0.002 | 0.018 | 0.002 | 0.019 | 0.0001 | 0.001 | 0.03 | 0.26 |
| S4 | 0.018 | 0.171 | 0.002 | 0.022 | 0.002 | 0.021 | 0.0002 | 0.002 | 0.07 | 0.61 |
| S5 | 0.007 | 0.064 | 0.001 | 0.011 | 0.001 | 0.009 | 0.0002 | 0.002 | 0.02 | 0.18 |
| S6 | 0.007 | 0.064 | 0.001 | 0.007 | 0.001 | 0.010 | 0.0003 | 0.002 | 0.04 | 0.35 |
| S7 | 0.032 | 0.299 | 0.003 | 0.029 | 0.003 | 0.030 | 0.0003 | 0.002 | 0.05 | 0.45 |
| S8 | 0.028 | 0.256 | 0.003 | 0.029 | 0.003 | 0.027 | 0.0002 | 0.002 | 0.06 | 0.52 |
| S9 | 0.023 | 0.214 | 0.003 | 0.029 | 0.003 | 0.025 | 0.0003 | 0.003 | 0.04 | 0.37 |
| S10 | 0.032 | 0.299 | 0.004 | 0.040 | 0.004 | 0.038 | 0.0003 | 0.003 | 0.06 | 0.55 |
| S11 | 0.028 | 0.256 | 0.005 | 0.048 | 0.003 | 0.032 | 0.0003 | 0.003 | 0.05 | 0.44 |
| S12 | 0.028 | 0.256 | 0.004 | 0.040 | 0.000 | 0.036 | 0.0003 | 0.003 | 0.05 | 0.51 |
| S13 | 0.023 | 0.214 | 0.004 | 0.040 | 0.003 | 0.031 | 0.0003 | 0.002 | 0.05 | 0.47 |
| S14 | 0.032 | 0.299 | 0.005 | 0.048 | 0.004 | 0.035 | 0.0003 | 0.003 | 0.05 | 0.50 |
| S15 | 0.018 | 0.171 | 0.002 | 0.022 | 0.002 | 0.019 | 0.0002 | 0.002 | 0.03 | 0.32 |
| S16 | 0.018 | 0.171 | 0.003 | 0.029 | 0.003 | 0.024 | 0.0003 | 0.003 | 0.04 | 0.40 |
| S17 | 0.018 | 0.171 | 0.003 | 0.026 | 0.002 | 0.019 | 0.0002 | 0.001 | 0.04 | 0.33 |
| S18 | 0.028 | 0.256 | 0.004 | 0.040 | 0.004 | 0.033 | 0.0003 | 0.003 | 0.05 | 0.47 |
| S19 | 0.023 | 0.214 | 0.004 | 0.037 | 0.003 | 0.031 | 0.0002 | 0.002 | 0.04 | 0.41 |
| S20 | 0.018 | 0.171 | 0.002 | 0.015 | 0.001 | 0.009 | 0.0001 | 0.001 | 0.03 | 0.28 |
| S21 | 0.023 | 0.214 | 0.003 | 0.026 | 0.002 | 0.019 | 0.0002 | 0.002 | 0.04 | 0.38 |
| S22 | 0.014 | 0.128 | 0.002 | 0.018 | 0.002 | 0.015 | 0.0002 | 0.002 | 0.03 | 0.29 |
| S23 | 0.014 | 0.128 | 0.002 | 0.015 | 0.001 | 0.012 | 0.0001 | 0.001 | 0.02 | 0.21 |
| S24 | 0.014 | 0.128 | 0.002 | 0.015 | 0.002 | 0.016 | 0.0002 | 0.002 | 0.04 | 0.33 |
| S25 | 0.018 | 0.171 | 0.002 | 0.015 | 0.002 | 0.015 | 0.0002 | 0.002 | 0.02 | 0.22 |
| S26 | 0.014 | 0.128 | 0.002 | 0.015 | 0.002 | 0.015 | 0.0001 | 0.001 | 0.03 | 0.24 |
| S27 | 0.014 | 0.128 | 0.002 | 0.015 | 0.002 | 0.015 | 0.0001 | 0.001 | 0.02 | 0.23 |
| S28 | 0.014 | 0.128 | 0.002 | 0.018 | 0.002 | 0.015 | 0.0001 | 0.001 | 0.03 | 0.24 |
| S29 | 0.009 | 0.085 | 0.001 | 0.011 | 0.001 | 0.007 | 0.0001 | 0.001 | 0.02 | 0.14 |
| S30 | 0.009 | 0.085 | 0.002 | 0.015 | 0.001 | 0.011 | 0.0001 | 0.001 | 0.02 | 0.22 |
| S31 | 0.014 | 0.128 | 0.002 | 0.015 | 0.002 | 0.016 | 0.0001 | 0.001 | 0.03 | 0.25 |
| S32 | 0.014 | 0.128 | 0.002 | 0.018 | 0.002 | 0.015 | 0.0002 | 0.001 | 0.02 | 0.23 |
| S33 | 0.009 | 0.085 | 0.002 | 0.015 | 0.001 | 0.012 | 0.0001 | 0.001 | 0.02 | 0.18 |
| S34 | 0.014 | 0.128 | 0.002 | 0.018 | 0.002 | 0.017 | 0.0001 | 0.001 | 0.03 | 0.25 |

Table S. 6. LCR values associated with As and Pb for both adults and children.

|  |  |  |
| --- | --- | --- |
| S.N. | As | Pb |
| Adults | Children | Adults | Children |
| S1 | 4.13E-06 | 3.84E-05 | 3.51E-08 | 3.27E-07 |
| S2 | 1.44E-05 | 0.000135 | 9.35E-08 | 8.71E-07 |
| S3 | 8.25E-06 | 7.69E-05 | 5.85E-08 | 5.44E-07 |
| S4 | 8.25E-06 | 7.69E-05 | 7.01E-08 | 6.53E-07 |
| S5 | 3.09E-06 | 2.88E-05 | 3.51E-08 | 3.27E-07 |
| S6 | 3.09E-06 | 2.88E-05 | 2.34E-08 | 2.18E-07 |
| S7 | 1.44E-05 | 0.000135 | 9.35E-08 | 8.71E-07 |
| S8 | 1.24E-05 | 0.000115 | 9.35E-08 | 8.71E-07 |
| S9 | 1.03E-05 | 9.61E-05 | 9.35E-08 | 8.71E-07 |
| S10 | 1.44E-05 | 0.000135 | 1.29E-07 | 1.2E-06 |
| S11 | 1.24E-05 | 0.000115 | 1.52E-07 | 1.42E-06 |
| S12 | 1.24E-05 | 0.000115 | 1.29E-07 | 1.2E-06 |
| S13 | 1.03E-05 | 9.61E-05 | 1.29E-07 | 1.2E-06 |
| S14 | 1.44E-05 | 0.000135 | 1.52E-07 | 1.42E-06 |
| S15 | 8.25E-06 | 7.69E-05 | 7.01E-08 | 6.53E-07 |
| S16 | 8.25E-06 | 7.69E-05 | 9.35E-08 | 8.71E-07 |
| S17 | 8.25E-06 | 7.69E-05 | 8.18E-08 | 7.62E-07 |
| S18 | 1.24E-05 | 0.000115 | 1.29E-07 | 1.2E-06 |
| S19 | 1.03E-05 | 9.61E-05 | 1.17E-07 | 1.09E-06 |
| S20 | 8.25E-06 | 7.69E-05 | 4.68E-08 | 4.36E-07 |
| S21 | 1.03E-05 | 9.61E-05 | 8.18E-08 | 7.62E-07 |
| S22 | 6.19E-06 | 5.76E-05 | 5.85E-08 | 5.44E-07 |
| S23 | 6.19E-06 | 5.76E-05 | 4.68E-08 | 4.36E-07 |
| S24 | 6.19E-06 | 5.76E-05 | 4.68E-08 | 4.36E-07 |
| S25 | 8.25E-06 | 7.69E-05 | 4.68E-08 | 4.36E-07 |
| S26 | 6.19E-06 | 5.76E-05 | 4.68E-08 | 4.36E-07 |
| S27 | 6.19E-06 | 5.76E-05 | 4.68E-08 | 4.36E-07 |
| S28 | 6.19E-06 | 5.76E-05 | 5.85E-08 | 5.44E-07 |
| S29 | 4.13E-06 | 3.84E-05 | 3.51E-08 | 3.27E-07 |
| S30 | 4.13E-06 | 3.84E-05 | 4.68E-08 | 4.36E-07 |
| S31 | 6.19E-06 | 5.76E-05 | 4.68E-08 | 4.36E-07 |
| S32 | 6.19E-06 | 5.76E-05 | 5.85E-08 | 5.44E-07 |
| S33 | 4.13E-06 | 3.84E-05 | 4.68E-08 | 4.36E-07 |
| S34 | 6.19E-06 | 5.76E-05 | 5.85E-08 | 5.44E-07 |