

## **SUPPLEMENTARY MATERIAL**

### **Conceptual modelling of land cover change effects on groundwater quality in Amman-Zarqa Basin, Jordan**

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**Table S1.** Major ions concentration in well water samples collected in 2002

| Name                            | ID     | Type   | Label ID | Bicarbonate         | Calcium | Chloride | Sodium  | Sulphate | Magnesium | Potassium |
|---------------------------------|--------|--------|----------|---------------------|---------|----------|---------|----------|-----------|-----------|
|                                 |        |        |          | mg·dm <sup>-3</sup> |         |          |         |          |           |           |
| Abu Nusair Society              | AL2344 | well   | 1        | 262.30              | 67.94   | 60.00    | 44.39   | 52.80    | 21.52     | 4.69      |
| Abu Nusair                      | AL1393 | well   | 2        | 186.88              | 55.32   | 202.07   | 91.92   | 61.41    | 40.23     | 2.14      |
| Abu Zeigan No. 1                | AL3674 | well   | 3        | 1306.01             | 698.39  | 3088.50  | 1932.00 | 1593.12  | 117.22    | 156.40    |
| Abu Zeigan No. 13               | AL3732 | well   | 4        | 1483.52             | 695.59  | 2572.33  | 1610.00 | 1504.32  | 158.93    | 153.27    |
| Abu Zeigan No. 3                | AL3676 | well   | 5        | 1071.77             | 616.23  | 2520.50  | 1587.00 | 1496.64  | 159.54    | 78.20     |
| Abu Zeigan No. 7                | AL3697 | well   | 6        | 1667.74             | 95.99   | 3205.30  | 2311.50 | 1882.08  | 597.18    | 218.96    |
| Abu Zeigan No. 5                | AL3759 | well   | 7        | 282.43              | 92.99   | 65.32    | 32.20   | 50.40    | 24.93     | 3.52      |
| Arnoos Al Uqail                 | AL1072 | well   | 8        | 155.55              | 89.58   | 396.18   | 231.15  | 250.56   | 51.07     | 10.56     |
| Arnoos Al Uqail No. 2           | AL1073 | well   | 9        | 151.89              | 64.33   | 305.66   | 211.37  | 192.96   | 53.14     | 9.38      |
| Arnoos Al Uqail Ulemat          | AL3969 | well   | 10       | 135.27              | 68.30   | 291.92   | 180.80  | 185.23   | 40.90     | 4.65      |
| Dafi Saleem Shakhatreh          | AL1507 | well   | 11       | 134.23              | 67.26   | 290.88   | 179.76  | 184.17   | 39.84     | 3.61      |
| Elias Elmoasher 2(PP473)        | AL1060 | well   | 12       | 133.22              | 67.31   | 289.94   | 179.82  | 184.90   | 39.90     | 3.63      |
| Hazeem Husain Saleem & Partners | AL1079 | well   | 13       | 104.31              | 64.73   | 319.50   | 149.50  | 96.48    | 36.48     | 8.60      |
| Iron and Steel Co.              | AL1332 | well   | 14       | 340.38              | 116.63  | 306.72   | 149.50  | 45.12    | 43.90     | 6.65      |
| Qunayyah                        | AL3781 | well   | 15       | 134.28              | 67.30   | 290.92   | 179.80  | 183.21   | 39.88     | 3.65      |
| Ruseifa No. 8                   | AL1444 | well   | 16       | 384.30              | 105.01  | 222.94   | 122.13  | 62.88    | 43.29     | 8.21      |
| Sabha No. 1A new                | AL3643 | well   | 17       | 144.57              | 25.05   | 78.10    | 61.87   | 28.32    | 15.44     | 6.65      |
| Sabha 1B / thermal              | AL3889 | spring | 18       | 135.19              | 65.23   | 290.85   | 182.73  | 187.14   | 39.81     | 3.58      |
| Sabha & Subhiyeh (oil)/Harara   | AL2709 | spring | 19       | 134.24              | 66.27   | 290.89   | 179.77  | 183.18   | 39.85     | 3.62      |
| Hamed Mohammed Alsalem          | AL3146 | well   | 20       | 134.23              | 66.26   | 290.88   | 179.76  | 183.17   | 39.84     | 3.61      |
| Shawkat Sbool                   | AL3259 | well   | 21       | 187.88              | 56.31   | 199.06   | 89.92   | 59.40    | 41.22     | 3.13      |
| Yajuz No. 1                     | AL1637 | well   | 22       | 1071.77             | 616.23  | 2520.50  | 1587.00 | 1496.64  | 159.54    | 78.20     |
| Al Elbeit University 3          | AL3468 | well   | 23       | 135.24              | 68.27   | 291.89   | 180.77  | 185.18   | 40.85     | 4.62      |
| Al Elbeit University 2          | AL3467 | well   | 24       | 135.24              | 68.27   | 291.89   | 180.77  | 185.18   | 40.85     | 4.62      |
| Shallaleh (El Balad)            | AL0856 | spring | 25       | 318.50              | 89.20   | 95.70    | 51.80   | 51.40    | 28.30     | 4.70      |

Source: own elaboration data of Water Authority of Jordan.

**Table S2.** Major ions concentration in well water samples collected in 2022

| Name                            | ID     | Type   | Label ID | Bicarbonate         | Calcium | Chloride | Sodium | Sulphate | Magnesium | Potassium |
|---------------------------------|--------|--------|----------|---------------------|---------|----------|--------|----------|-----------|-----------|
|                                 |        |        |          | mg·dm <sup>-3</sup> |         |          |        |          |           |           |
| Abu Nusair Society              | AL2344 | well   | 1        | 187.90              | 56.33   | 203.08   | 92.94  | 62.42    | 41.24     | 3.15      |
| Abu Nusair                      | AL1393 | well   | 2        | 187.88              | 56.32   | 203.07   | 92.92  | 62.41    | 41.23     | 3.14      |
| Abu Zeigan No. 1                | AL3674 | well   | 3        | 210.10              | 58.30   | 154.60   | 83.90  | 63.40    | 27.70     | 6.90      |
| Abu Zeigan No. 13               | AL3732 | well   | 4        | 115.29              | 59.32   | 261.28   | 111.32 | 99.36    | 42.56     | 11.34     |
| Abu Zeigan No. 3                | AL3676 | well   | 5        | 237.00              | 75.00   | 90.03    | 57.00  | 18.36    | 28.30     | 1.03      |
| Abu Zeigan No. 7                | AL3697 | well   | 6        | 733.90              | 348.6   | 757.70   | 518.50 | 671.00   | 73.10     | 65.00     |
| Abu Zeigan No. 5                | AL3759 | well   | 7        | 115.27              | 59.30   | 261.27   | 111.31 | 99.35    | 42.55     | 11.33     |
| Arnoos Al Uqail                 | AL1072 | well   | 8        | 137.24              | 70.32   | 293.93   | 182.84 | 187.10   | 42.91     | 6.64      |
| Arnoos Al Uqail No. 2           | AL1073 | well   | 9        | 137.25              | 70.34   | 293.94   | 182.85 | 187.22   | 42.92     | 6.65      |
| Arnoos Al Uqail Ulemat          | AL3969 | well   | 10       | 137.27              | 70.30   | 293.92   | 182.80 | 187.23   | 42.90     | 6.65      |
| Dafi Saleem Shakhatreh          | AL1507 | well   | 11       | 137.23              | 70.26   | 293.88   | 182.76 | 187.17   | 42.84     | 6.61      |
| Elias Elmoasher 2(PP473)        | AL1060 | well   | 12       | 137.22              | 70.31   | 293.94   | 182.82 | 187.90   | 42.90     | 6.63      |
| Hazeem Husain Saleem & Partners | AL1079 | well   | 13       | 137.24              | 70.33   | 293.93   | 182.83 | 187.20   | 42.91     | 6.64      |
| Iron and Steel Co.              | AL1332 | well   | 14       | 225.89              | 89.69   | 167.79   | 71.89  | 19.99    | 35.39     | 1.39      |
| Qunayyah                        | AL3781 | well   | 15       | 137.28              | 70.30   | 293.92   | 182.80 | 187.21   | 42.88     | 6.65      |
| Ruseifa No. 8                   | AL1444 | well   | 16       | 225.90              | 89.70   | 167.80   | 71.90  | 20.00    | 35.40     | 1.40      |
| Sabha No.1A new                 | AL3643 | well   | 17       | 137.22              | 70.25   | 293.87   | 182.75 | 187.16   | 42.83     | 6.60      |
| Sabha 1B / thermal              | AL3889 | spring | 18       | 137.19              | 70.23   | 293.85   | 182.73 | 187.14   | 42.81     | 6.58      |
| Sabha & Subhiyeh (oil)/Harara   | AL2709 | spring | 19       | 137.24              | 70.27   | 293.89   | 182.77 | 187.18   | 42.85     | 6.62      |
| Hamed Mohammed Alsalem          | AL3146 | well   | 20       | 137.23              | 70.26   | 293.88   | 182.76 | 187.17   | 42.84     | 6.61      |
| Shawkat Sbool                   | AL3259 | well   | 21       | 187.88              | 56.31   | 203.06   | 92.92  | 62.40    | 41.22     | 3.13      |
| Yajuz No. 1 Well                | AL1637 | well   | 22       | 225.90              | 89.70   | 167.80   | 71.90  | 20.00    | 35.40     | 1.40      |
| Al Elbeit University 3          | AL3468 | well   | 23       | 137.24              | 70.27   | 293.89   | 182.77 | 187.18   | 42.85     | 6.62      |
| Al Elbeit University 2          | AL3467 | well   | 24       | 137.24              | 70.27   | 293.89   | 182.77 | 187.18   | 42.85     | 6.62      |
| Shallaleh (El Balad) Spring     | AL0856 | spring | 25       | 320.50              | 91.20   | 99.70    | 55.80  | 55.40    | 32.30     | 6.70      |

Source: own elaboration data of Water Authority of Jordan.

**Table S3.** Heavy metal levels in well water samples collected in 2002

| Location                      | ID     | Label ID | Chromium            | Lead | Manganese | Nickel | Copper |
|-------------------------------|--------|----------|---------------------|------|-----------|--------|--------|
|                               |        |          | mg·dm <sup>-3</sup> |      |           |        |        |
| Abu Nusair Society            | AL2344 | 1        | 0.00                | 0.00 | 0.00      | 0.00   | 0.00   |
| Abu Zeigan No. 1              | AL3675 | 3        | 0.01                | 0.01 | 0.02      | 0.01   | 0.01   |
| Abu Zeigan No. 13             | AL3732 | 4        | 0.01                | 0.01 | 0.02      | 0.02   | 0.01   |
| Abu Zeigan No. 3              | AL3676 | 5        | 0.00                | 0.00 | 0.02      | 0.00   | 0.00   |
| Abu Zeigan No. 7              | AL3697 | 6        | 0.01                | 0.01 | 0.02      | 0.01   | 0.02   |
| Shawkat Sbool                 | AL3259 | 7        | 0.01                | 0.01 | 0.02      | 0.01   | 0.01   |
| Arnoos Al Uqail No. 2         | AL1073 | 9        | 0.01                | 0.01 | 0.02      | 0.01   | 0.01   |
| Hazeem Husain Saleem & Parts. | AL1079 | 13       | 0.00                | 0.00 | 0.02      | 0.00   | 0.00   |
| Iron and Steel Co.            | AL1332 | 14       | 0.00                | 0.00 | 0.02      | 0.00   | 0.00   |
| Ruseifa No. 8                 | AL1444 | 16       | 0.00                | 0.00 | 0.02      | 0.01   | 0.00   |
| Sabha No. 1A new              | AL3643 | 17       | 0.00                | 0.00 | 0.02      | 0.00   | 0.00   |

Source: own elaboration data of Water Authority of Jordan.

**Table S4.** Heavy metal levels in well water samples collected in 2022

| Location                      | ID     | Label ID | Chromium            | Lead | Manganese | Nickel | Copper |
|-------------------------------|--------|----------|---------------------|------|-----------|--------|--------|
|                               |        |          | mg·dm <sup>-3</sup> |      |           |        |        |
| Abu Nusair Society            | AL2344 | 1        | 0.00                | 0.00 | 0.00      | 0.00   | 0.00   |
| Abu Zeigan No. 1              | AL3675 | 3        | 0.01                | 0.02 | 0.02      | 0.01   | 0.02   |
| Abu Zeigan No. 13             | AL3732 | 4        | 0.02                | 0.02 | 0.03      | 0.03   | 0.01   |
| Abu Zeigan No. 3              | AL3676 | 5        | 0.00                | 0.01 | 0.01      | 0.01   | 0.01   |
| Abu Zeigan No. 7              | AL3697 | 6        | 0.01                | 0.02 | 0.01      | 0.01   | 0.02   |
| Shawkat Sbool                 | AL3259 | 7        | 0.00                | 0.00 | 0.00      | 0.00   | 0.00   |
| Arnoos Al Uqail No. 2         | AL1073 | 9        | 0.05                | 0.05 | 0.05      | 0.01   | 0.02   |
| Hazeem Husain Saleem & Parts. | AL1079 | 13       | 0.05                | 0.05 | 0.05      | 0.01   | 0.02   |
| Iron and Steel Co.            | AL1332 | 14       | 0.05                | 0.05 | 0.06      | 0.01   | 0.02   |
| Ruseifa No. 8                 | AL1444 | 16       | 0.05                | 0.05 | 0.06      | 0.00   | 0.02   |
| Sabha No. 1A new              | AL3643 | 17       | 0.05                | 0.05 | 0.00      | 0.01   | 0.02   |

Source: own elaboration data of Water Authority of Jordan.