

## Supplementary materials

Table S1. Precipitation, antecedent wetness and discharge characteristics for the 20 events.

| ID | Event date | $P$  | $T$  | $P_{int}$             | $Q_{ini}$             | $ST5_{ini}$ | $ST30_{ini}$ | $ST70_{ini}$ | $SF5_{ini}$ | $SF30_{ini}$ | $SF70_{ini}$ | $Q_{total}$ | $Q_e$  | $Q_{pe}$ | $\frac{Q_{total}}{P}$ | $\frac{Q_e}{Q_{total}}$ | $\frac{Q_{pe}}{Q_{total}}$ |
|----|------------|------|------|-----------------------|-----------------------|-------------|--------------|--------------|-------------|--------------|--------------|-------------|--------|----------|-----------------------|-------------------------|----------------------------|
|    |            | (mm) | (h)  | (mm h <sup>-1</sup> ) | (mm h <sup>-1</sup> ) | (%)         | (%)          | (%)          | (%)         | (%)          | (%)          | (mm)        | (mm)   | (mm)     | (%)                   | (%)                     | (%)                        |
| 1  | 9 Aug      | 1.0  | 0.2  | 6.1                   | 0.003                 | 18.2        | 21.2         | 39.3         | 13.3        | 8.7          | 21.6         | 0.151       | 0.0044 | 0.146    | 14.8                  | 3.0                     | 97.0                       |
| 2  | 25 Aug     | 1.5  | 3.0  | 0.5                   | 0.002                 | 12.8        | 19.0         | 37.6         | 6.8         | 8.7          | 21.2         | 0.038       | 0.0045 | 0.034    | 2.5                   | 11.9                    | 88.1                       |
| 3  | 27 Aug     | 0.3  | 2.6  | 0.1                   | 0.002                 | 13.1        | 19.2         | 37.8         | 6.6         | 8.5          | 21.1         | 0.029       | 0.0004 | 0.028    | 9.3                   | 1.4                     | 98.6                       |
| 4  | 29 Aug     | 2.7  | 6.1  | 0.4                   | 0.002                 | 12.7        | 19.1         | 37.6         | 6.6         | 8.5          | 20.8         | 0.110       | 0.0194 | 0.091    | 4.1                   | 17.6                    | 82.4                       |
| 5  | 7 Sep      | 1.4  | 0.2  | 5.5                   | 0.002                 | 12.5        | 18.5         | 39.2         | 6.3         | 8.5          | 20.7         | 0.028       | 0.0031 | 0.024    | 2.0                   | 11.1                    | 88.9                       |
| 6  | 21 Sep     | 4.2  | 1.9  | 2.2                   | 0.002                 | 11.7        | 17.8         | 37.2         | 6.1         | 8.3          | 19.7         | 0.045       | 0.0016 | 0.043    | 1.1                   | 3.7                     | 96.3                       |
| 7  | 22 Sep     | 17.1 | 20.3 | 0.8                   | 0.001                 | 11.7        | 17.8         | 37.6         | 6.0         | 8.2          | 19.7         | 0.067       | 0.0059 | 0.061    | 0.4                   | 8.8                     | 91.2                       |
| 8  | 24 Sep     | 0.9  | 0.3  | 3.4                   | 0.001                 | 20.7        | 19.1         | 39.0         | 12.2        | 7.9          | 19.6         | 0.007       | 0.0002 | 0.007    | 0.8                   | 2.4                     | 97.6                       |
| 9  | 1 Oct      | 0.8  | 0.2  | 4.6                   | 0.001                 | 18.1        | 19.2         | 38.9         | 10.0        | 8.0          | 19.7         | 0.006       | 0.0001 | 0.005    | 0.7                   | 2.4                     | 97.6                       |
| 10 | 2 Oct      | 1.5  | 3.7  | 0.4                   | 0.001                 | 18.0        | 19.4         | 39.5         | 9.5         | 7.8          | 19.5         | 0.008       | 0.0017 | 0.006    | 0.5                   | 20.8                    | 79.2                       |
| 11 | 3 Oct      | 0.8  | 5.4  | 0.2                   | 0.001                 | 20.7        | 19.5         | 39.4         | 9.6         | 7.6          | 19.5         | 0.013       | 0.0011 | 0.012    | 1.6                   | 8.1                     | 91.9                       |
| 12 | 24 Oct     | 0.9  | 7.8  | 0.1                   | 0.001                 | 16.0        | 20.3         | 39.8         | 7.2         | 7.9          | 19.9         | 0.005       | 0.0001 | 0.005    | 0.6                   | 2.2                     | 97.8                       |
| 13 | 25 Oct     | 0.6  | 4.9  | 0.1                   | 0.001                 | 15.9        | 20.3         | 40.1         | 7.3         | 8.0          | 19.9         | 0.009       | 0.0005 | 0.008    | 1.5                   | 5.5                     | 94.5                       |
| 14 | 10 Nov     | 0.9  | 0.5  | 1.9                   | 0.001                 | 22.3        | 21.0         | 40.0         | 7.1         | 7.9          | 19.7         | 0.010       | 0.0002 | 0.010    | 1.1                   | 2.5                     | 97.5                       |
| 15 | 10 Nov     | 4.2  | 15.4 | 0.3                   | 0.001                 | 23.7        | 21.1         | 40.3         | 7.1         | 7.8          | 19.7         | 0.029       | 0.0014 | 0.028    | 0.7                   | 4.9                     | 95.1                       |
| 16 | 24 Nov     | 1.3  | 2.4  | 0.5                   | 0.001                 | 29.2        | 25.9         | 39.9         | 12.8        | 7.7          | 19.5         | 0.012       | 0.0004 | 0.012    | 0.9                   | 3.4                     | 96.6                       |
| 17 | 28 Nov     | 1.6  | 3.8  | 0.4                   | 0.001                 | 29.1        | 25.9         | 39.7         | 12.8        | 7.8          | 19.5         | 0.007       | 0.0009 | 0.006    | 0.5                   | 12.2                    | 87.8                       |
| 18 | 30 Nov     | 1.3  | 6.7  | 0.2                   | 0.001                 | 28.0        | 26.3         | 39.9         | 13.4        | 7.8          | 19.9         | 0.006       | 0.0006 | 0.006    | 0.5                   | 9.2                     | 90.8                       |
| 19 | 1 Dec      | 19.6 | 41.8 | 0.5                   | 0.001                 | 27.9        | 26.6         | 39.9         | 13.8        | 7.8          | 19.9         | 0.070       | 0.0113 | 0.059    | 0.4                   | 16.0                    | 84.0                       |
| 20 | 6 Dec      | 1.0  | 4.8  | 0.2                   | 0.001                 | 28.2        | 29.1         | 40.0         | 17.8        | 8.2          | 20.0         | 0.006       | 0.0003 | 0.005    | 0.5                   | 5.1                     | 94.9                       |

Table S2. Maximum event water fraction  $F_{E_{max}}$ , uncertainty of maximum event water fraction  $W_{FE}$  and response time  $T_{F_{E_{max}}}$  of stream water and groundwater sources derived from  $\delta^2\text{H}$  values for the 20 events.

| ID | $F_{E_{max}} \pm W_{FE}$<br>(%) |   |      |      |   |      |      |   |      |      |   |      |      |   |      | $T_{F_{E_{max}}}$<br>(h) |      |      |      |      |
|----|---------------------------------|---|------|------|---|------|------|---|------|------|---|------|------|---|------|--------------------------|------|------|------|------|
|    | SW1                             |   |      | SW2  |   |      | GW1  |   |      | GW2  |   |      | GW3  |   |      | SW1                      | SW2  | GW1  | GW2  | GW3  |
| 1  | 6.2                             | ± | 2.0  | 4.5  | ± | 2.2  | 2.4  | ± | 1.8  | 4.1  | ± | 1.9  | 5.4  | ± | 1.8  | 0.3                      | 1.2  | 2.3  | 1.6  | 0.6  |
| 2  | -                               | ± | -    | 30.9 | ± | 11.6 | 16.3 | ± | 13.7 | 13.7 | ± | 9.0  | 10.7 | ± | 8.0  | -                        | 14.1 | 17.6 | 19.7 | 18.7 |
| 3  | -                               | ± | -    | 3.1  | ± | 2.5  | 2.3  | ± | 2.2  | 2.1  | ± | 1.3  | 2.4  | ± | 1.5  | -                        | 8.1  | 6.3  | 5.8  | 2.2  |
| 4  | 40.7                            | ± | 10.9 | 46.2 | ± | 9.6  | 3.3  | ± | 2.6  | 10.5 | ± | 3.5  | 6.3  | ± | 1.5  | 1.3                      | 0.7  | 9.8  | 6.2  | 1.6  |
| 5  | 23.1                            | ± | 8.9  | 25.3 | ± | 8.5  | 8.4  | ± | 6.8  | 8.3  | ± | 6.7  | 7.3  | ± | 5.3  | 3.0                      | 2.3  | 3.3  | 2.6  | 1.6  |
| 6  | 15.1                            | ± | 4.4  | 9.4  | ± | 4.0  | 3.5  | ± | 2.5  | 2.4  | ± | 1.2  | 4.6  | ± | 3.0  | 3.5                      | 4.1  | 4.5  | 3.8  | 5.8  |
| 7  | 36.0                            | ± | 4.5  | 27.3 | ± | 3.4  | 1.8  | ± | 1.4  | 3.1  | ± | 1.5  | 2.6  | ± | 1.3  | 12.4                     | 13.0 | 8.0  | 7.1  | 9.6  |
| 8  | 8.1                             | ± | 2.0  | 8.3  | ± | 2.1  | 2.3  | ± | 2.1  | 3.4  | ± | 2.2  | 4.3  | ± | 2.1  | 1.0                      | 1.7  | 2.0  | 4.4  | 3.4  |
| 9  | 3.3                             | ± | 12.8 | 5.8  | ± | 8.2  | 2.0  | ± | 11.5 | 2.8  | ± | 11.4 | 4.5  | ± | 8.9  | 0.9                      | 1.9  | 2.2  | 4.6  | 3.3  |
| 10 | 33.1                            | ± | 8.6  | 36.4 | ± | 9.6  | 25.1 | ± | 5.9  | 20.5 | ± | 5.9  | 22.2 | ± | 4.9  | 1.7                      | 2.4  | 3.0  | 2.1  | 4.7  |
| 11 | 16.9                            | ± | 4.1  | 17.4 | ± | 3.5  | 5.3  | ± | 4.8  | 4.3  | ± | 3.3  | 8.1  | ± | 2.4  | 5.4                      | 7.4  | 6.4  | 5.8  | 7.8  |
| 12 | 3.5                             | ± | 2.5  | 6.2  | ± | 1.5  | 6.3  | ± | 1.7  | 5.0  | ± | 2.7  | 4.1  | ± | 2.3  | 7.4                      | 1.9  | 2.2  | 8.0  | 6.7  |
| 13 | 11.8                            | ± | 7.9  | 10.7 | ± | 9.4  | 3.1  | ± | 4.0  | 4.4  | ± | 4.0  | 6.3  | ± | 3.5  | 3.9                      | 4.2  | 6.4  | 5.8  | 1.2  |
| 14 | 10.2                            | ± | 7.0  | 12.1 | ± | 1.9  | 9.8  | ± | 1.8  | 5.6  | ± | 2.1  | 6.3  | ± | 2.2  | 6.5                      | 5.4  | 4.4  | 3.8  | 5.8  |
| 15 | 32.8                            | ± | 24.5 | 34.0 | ± | 25.0 | 30.3 | ± | 22.0 | 28.4 | ± | 13.9 | 34.9 | ± | 19.2 | 23.0                     | 23.6 | 8.3  | 3.8  | 16.3 |
| 16 | 10.6                            | ± | 1.4  | 13.6 | ± | 1.5  | 6.6  | ± | 1.4  | 7.9  | ± | 1.4  | 7.1  | ± | 1.7  | 9.8                      | 10.1 | 9.1  | 8.4  | 10.4 |
| 17 | 14.5                            | ± | 6.4  | 18.2 | ± | 7.7  | 29.8 | ± | 11.5 | 21.8 | ± | 8.5  | 22.6 | ± | 9.4  | 1.6                      | 3.9  | 16.1 | 15.5 | 17.5 |
| 18 | 22.1                            | ± | 34.3 | 20.4 | ± | 28.3 | 15.3 | ± | 23.1 | 16.1 | ± | 17.7 | 13.2 | ± | 25.9 | 3.2                      | 2.3  | 1.0  | 3.8  | 2.6  |
| 19 | 74.5                            | ± | 22.6 | 86.3 | ± | 27.0 | 31.9 | ± | 22.4 | 35.0 | ± | 25.9 | 19.2 | ± | 17.3 | 18.6                     | 17.6 | 23.3 | 33.0 | 28.2 |
| 20 | 7.6                             | ± | 17.5 | 11.4 | ± | 25.6 | 3.8  | ± | 10.2 | 5.8  | ± | 11.9 | 7.0  | ± | 14.8 | 4.3                      | 1.1  | 3.7  | 3.1  | 8.0  |

Table S3. Maximum event water fraction  $F_{E_{max}}$ , uncertainty of maximum event water fraction  $W_{FE}$  and response time  $T_{F_{E_{max}}}$  of stream water and groundwater sources derived from  $\delta^{18}\text{O}$  values for the 20 events.

| ID | $F_{E_{max}} \pm W_{FE}$<br>(%) |   |      |      |   |      |      |   |      |      |   |      |      |   |      | $T_{F_{E_{max}}}$<br>(h) |      |      |      |      |
|----|---------------------------------|---|------|------|---|------|------|---|------|------|---|------|------|---|------|--------------------------|------|------|------|------|
|    | SW1                             |   |      | SW2  |   |      | GW1  |   |      | GW2  |   |      | GW3  |   |      | SW1                      | SW2  | GW1  | GW2  | GW3  |
| 1  | 6.4                             | ± | 3.9  | 4.1  | ± | 4.1  | 2.6  | ± | 4.0  | 4.9  | ± | 3.8  | 3.6  | ± | 3.9  | 0.3                      | 1.2  | 2.3  | 1.6  | 0.6  |
| 2  | -                               | ± | -    | 33.2 | ± | 18.6 | 13.1 | ± | 22.9 | 10.3 | ± | 17.8 | 11.9 | ± | 16.7 | -                        | 14.1 | 17.6 | 19.7 | 18.7 |
| 3  | -                               | ± | -    | 5.7  | ± | 7.8  | 4.2  | ± | 8.1  | 4.8  | ± | 7.8  | 3.8  | ± | 8.0  | -                        | 8.1  | 6.3  | 5.8  | 2.2  |
| 4  | 40.2                            | ± | 22.7 | 46.9 | ± | 15.9 | 3.0  | ± | 11.7 | 7.8  | ± | 11.3 | 6.6  | ± | 11.0 | 1.3                      | 0.7  | 9.8  | 6.2  | 1.6  |
| 5  | 24.1                            | ± | 19.8 | 26.7 | ± | 21.3 | 8.0  | ± | 18.0 | 8.9  | ± | 17.1 | 7.8  | ± | 16.6 | 3.0                      | 2.3  | 3.3  | 2.6  | 1.6  |
| 6  | 15.4                            | ± | 10.1 | 10.3 | ± | 9.7  | 5.3  | ± | 9.0  | 3.5  | ± | 9.0  | 6.1  | ± | 7.8  | 3.5                      | 4.1  | 4.5  | 3.8  | 5.8  |
| 7  | 38.9                            | ± | 6.5  | 28.3 | ± | 6.1  | 1.5  | ± | 5.2  | 1.6  | ± | 4.8  | 1.6  | ± | 4.7  | 12.4                     | 13.0 | 8.0  | 7.1  | 9.6  |
| 8  | 8.6                             | ± | 6.9  | 7.7  | ± | 7.0  | 3.6  | ± | 7.8  | 2.6  | ± | 7.3  | 4.1  | ± | 7.2  | 1.0                      | 1.7  | 2.0  | 4.4  | 3.4  |
| 9  | 4.0                             | ± | 26.6 | 6.9  | ± | 26.5 | 3.0  | ± | 23.7 | 2.9  | ± | 20.4 | 1.6  | ± | 22.5 | 0.9                      | 1.9  | 2.2  | 4.6  | 3.3  |
| 10 | 27.1                            | ± | 10.4 | 25.5 | ± | 10.0 | 26.7 | ± | 9.2  | 24.4 | ± | 10.0 | 24.1 | ± | 8.3  | 1.7                      | 2.4  | 3.0  | 2.1  | 4.7  |
| 11 | 14.1                            | ± | 7.6  | 19.8 | ± | 7.2  | 8.0  | ± | 10.2 | 4.4  | ± | 11.5 | 10.9 | ± | 10.9 | 5.4                      | 7.4  | 6.4  | 5.8  | 7.8  |
| 12 | 6.0                             | ± | 6.1  | 4.5  | ± | 4.7  | 4.7  | ± | 4.8  | 4.3  | ± | 6.1  | 3.8  | ± | 5.7  | 7.4                      | 1.9  | 2.2  | 8.0  | 6.7  |
| 13 | 12.3                            | ± | 12.9 | 10.0 | ± | 13.8 | 6.1  | ± | 11.9 | 4.1  | ± | 12.8 | 7.9  | ± | 9.6  | 3.9                      | 4.2  | 6.4  | 5.8  | 1.2  |
| 14 | 9.6                             | ± | 9.5  | 10.4 | ± | 4.3  | 10.0 | ± | 4.3  | 5.2  | ± | 4.2  | 7.0  | ± | 4.0  | 6.5                      | 5.4  | 4.4  | 3.8  | 5.8  |
| 15 | 33.5                            | ± | 36.4 | 34.3 | ± | 38.6 | 33.0 | ± | 35.1 | 31.0 | ± | 15.9 | 35.5 | ± | 22.2 | 23.0                     | 23.6 | 8.3  | 3.8  | 16.3 |
| 16 | 9.3                             | ± | 3.9  | 12.0 | ± | 4.0  | 5.2  | ± | 3.9  | 5.3  | ± | 4.1  | 4.0  | ± | 4.4  | 9.8                      | 10.1 | 9.1  | 8.4  | 10.4 |
| 17 | 16.2                            | ± | 7.2  | 19.9 | ± | 8.5  | 31.8 | ± | 14.7 | 22.7 | ± | 9.2  | 21.5 | ± | 11.4 | 1.6                      | 3.9  | 16.1 | 15.5 | 17.5 |
| 18 | 19.5                            | ± | 45.6 | 18.4 | ± | 38.7 | 13.3 | ± | 26.4 | 16.2 | ± | 25.9 | 13.1 | ± | 28.3 | 3.2                      | 2.3  | 1.0  | 3.8  | 2.6  |
| 19 | 70.5                            | ± | 25.0 | 83.6 | ± | 31.6 | 31.5 | ± | 24.6 | 32.2 | ± | 27.1 | 17.5 | ± | 20.3 | 18.6                     | 17.6 | 23.3 | 33.0 | 28.2 |
| 20 | 9.4                             | ± | 20.2 | 11.3 | ± | 28.0 | 4.0  | ± | 15.0 | 6.3  | ± | 15.4 | 8.0  | ± | 17.8 | 4.3                      | 1.1  | 3.7  | 3.1  | 8.0  |