# On the value of high density rain gauge observations for small Alpine headwater catchment hydrology - *Supplementary Material, Part 1*

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**Summary:**

This Section 1 contains first of all supplementary figures describing the case study (hydrograph in Figure S1, picture of the streamflow gauging station disturbed by a rock in Figure S2, rating curve in Figure S3), followed by an illustration of the evolution of initial streamflow per streamflow event over the course of the year (Figure S4). Next, it shows the distribution of all distance metrics for all rainfall events over the entire catchment (Figure S5) and in the northern and southern part for the hillslope distance (Figure S6), a complete listing of all geomorphological distance metrics (Table S1). This is followed by a detailed comparison between the two spatial rainfall interpolation methods used in this paper (Figure S7) and additional details for the rain gauge network configuration analysis (Table S3, Table S4).

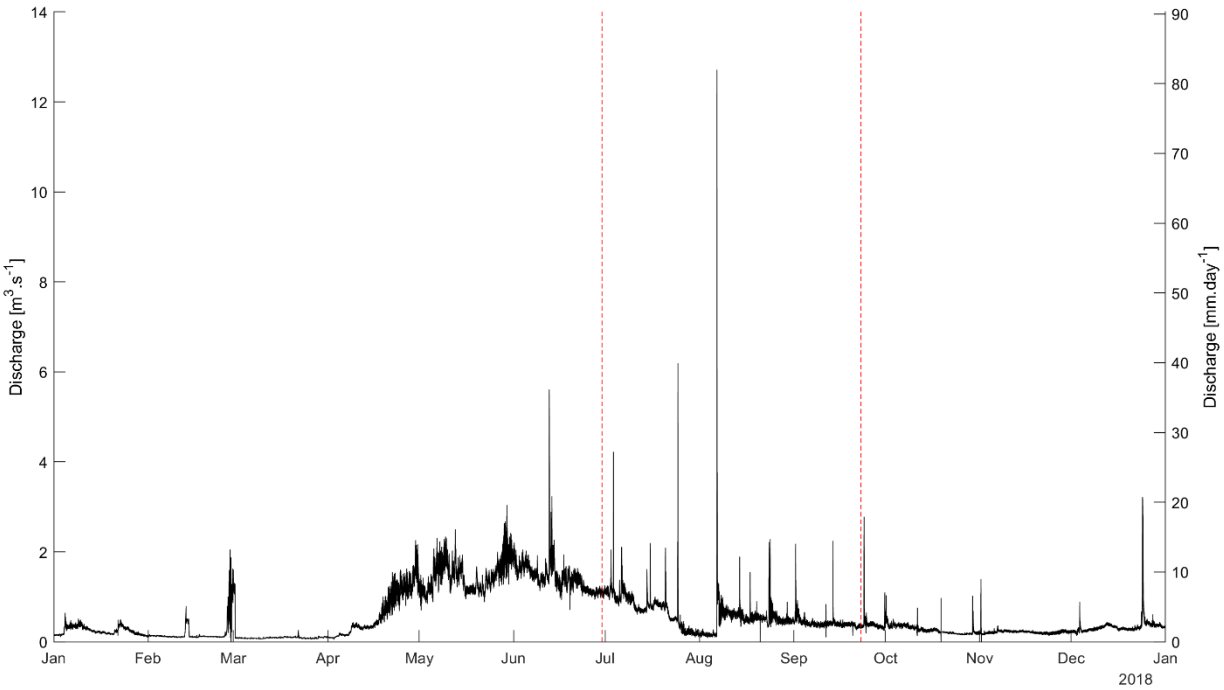


Figure S1. River discharge measured at the Vallon de Nant outlet (in $m^3.s^{-1}$ and $mm.day^{-1}$) over 2018. The study period (from July 1st 2018 to September 23th 2018) is marked out by the two red dashed lines.

Figure S2. Automatic picture of the Avançon de Nant measurement station at the Vallon de Nant outlet on July 30th 2018. The river stage measure by the SONAR above the middle point of the river is disturbed upstream by a rock.

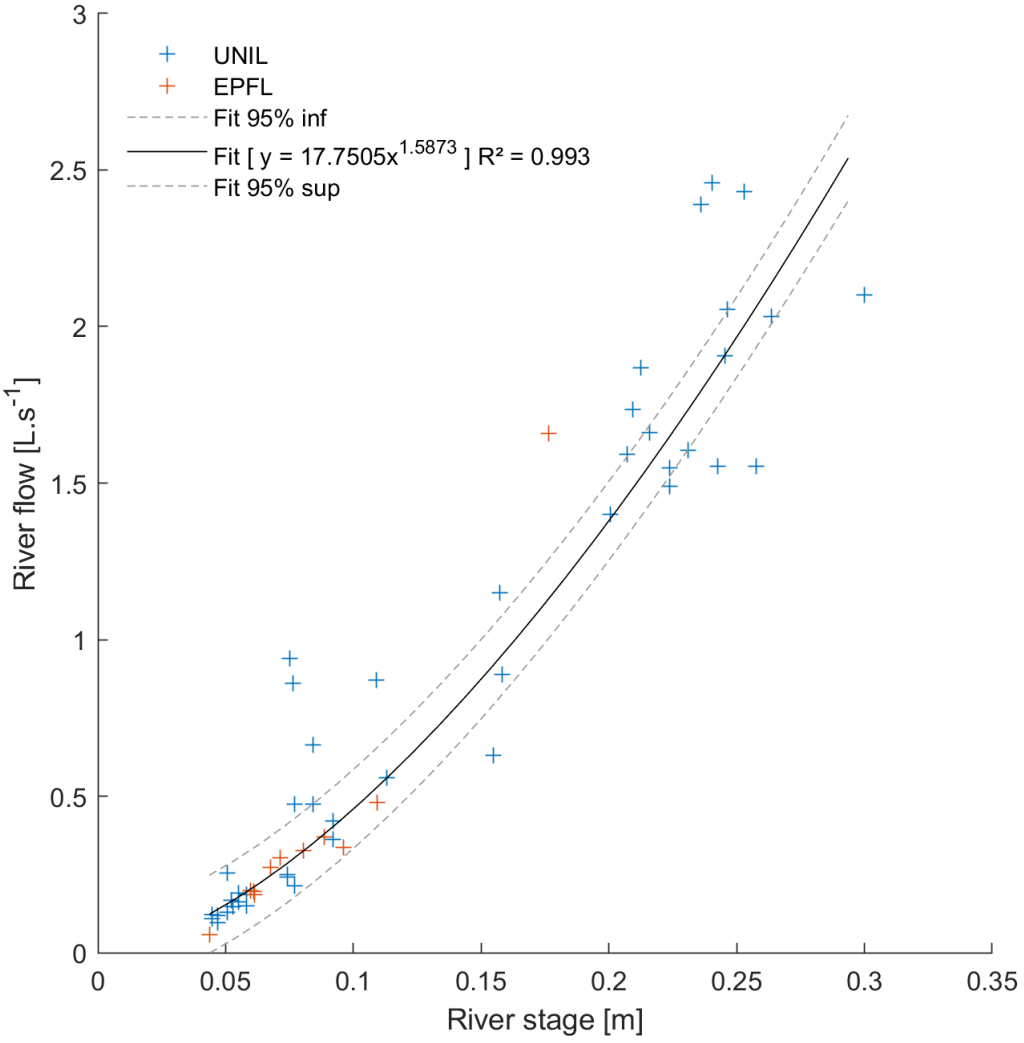


Figure S3. Rating curve for the *Avançon de Nant* river at the outlet of the Vallon de Nant based on 55 salt streamflow measurements realized by the Institute of Earth Surface Dynamics from the University of Lausanne (UNIL) and the Stream Biofilm and Ecosystem Research Laboratory, from the Ecole Polytechnique Fédérale de Lausanne (EPFL).

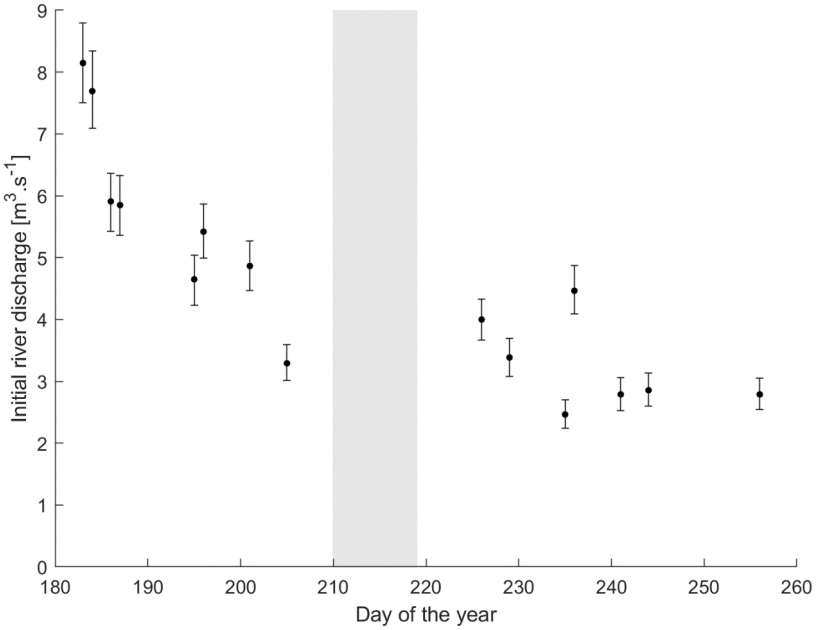


Figure S4. Initial streamflow for the 15 rainfall events causing a river reaction as function of the day of the year. The grey area corresponds to the period when the streamflow gauge readings were perturbed and thus discarded from the present analysis.

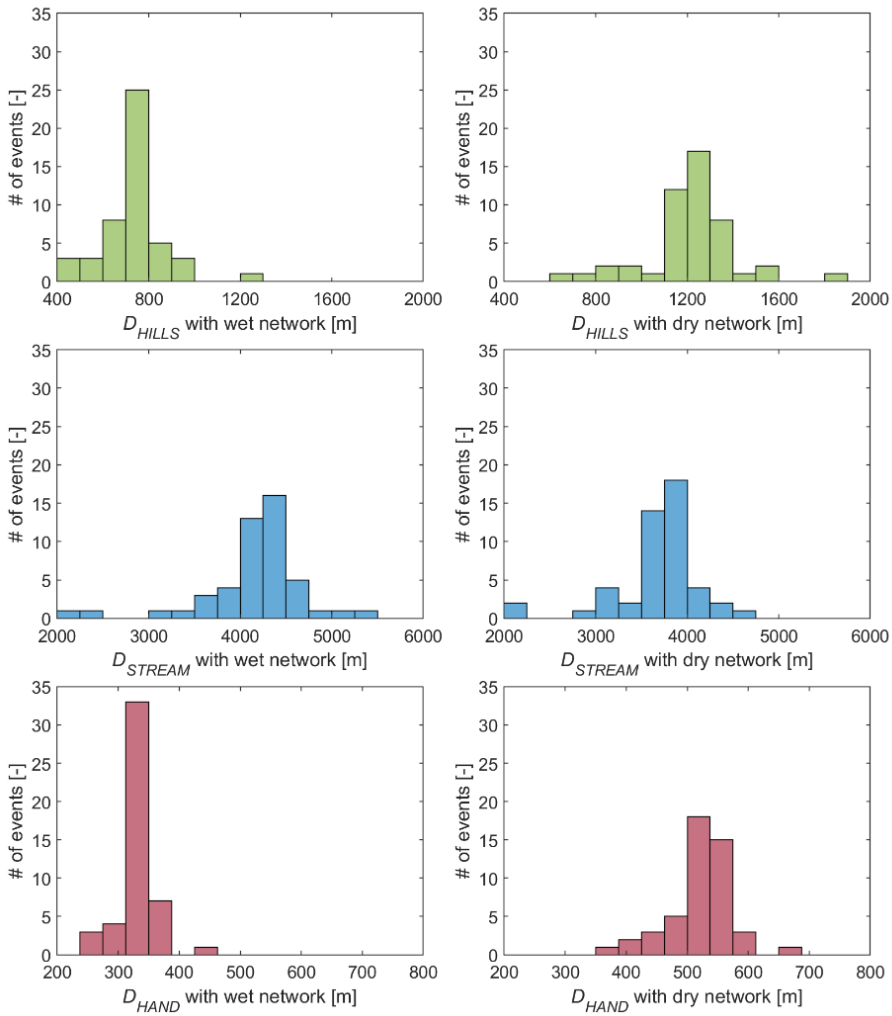


Figure S5. Distribution of the distance metrics for all 48 rainfall events.

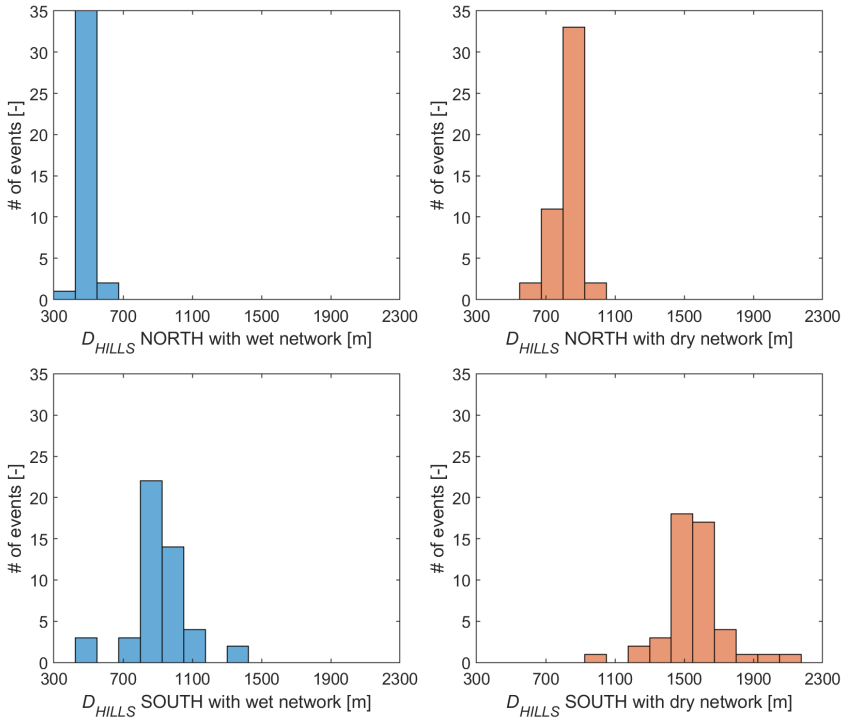


Figure S6: Distribution of $D_{HILLS}$ for the northern part (left column) and the southern part (right column) of the catch men, with respect to the wet network (top row) and the dry network (bottom row). The median of the wet distances are 329 m shorter than the dry distances in the northern part (top), in the southern part (bottom) they are 634 m shorter.

Table S1. Distance metrics for each streamflow event with respect to the extended (wet) and the retracted (dry) network and the combined distance if a threshold of antecedent precipitation of 20 mm is applied.

| | $D_{HILLS}$ [m] | | | $D_{STREAM}$ [m] | | | $D_{HAND}$ [m] | | |
|---|---|---|---|---|---|---|---|---|---|
| Network | *wet* | *dry* | *composite* | *wet* | *dry* | *composite* | *wet* | *dry* | *composite* |
| 2-Jul-18 | 925 | 1521 | 1521 | 4604 | 4008 | 4008 | 378 | 611 | 611 |
| 3-Jul-18 | 817 | 1336 | 1336 | 4361 | 3842 | 3842 | 350 | 550 | 550 |
| 5-Jul-18 | 755 | 1287 | 755 | 4374 | 3842 | 4374 | 350 | 557 | 350 |
| 6-Jul-18 | 874 | 1352 | 874 | 4450 | 3972 | 4450 | 355 | 536 | 355 |
| 14-Jul-18 | 736 | 1263 | 1263 | 4100 | 3574 | 3574 | 345 | 554 | 554 |
| 15-Jul-18 | 628 | 1122 | 1122 | 3871 | 3377 | 3377 | 326 | 528 | 528 |
| 20-Jul-18 | 758 | 1282 | 1282 | 4348 | 3823 | 3823 | 336 | 541 | 541 |
| 24-Jul-18 | 443 | 740 | 740 | 2481 | 2184 | 2184 | 278 | 419 | 419 |
| 14-Aug-18 | 784 | 1286 | 1286 | 4806 | 4305 | 4305 | 354 | 540 | 540 |
| 17-Aug-18 | 662 | 1122 | 1122 | 4240 | 3780 | 3780 | 313 | 490 | 490 |
| 23-Aug-18 | 854 | 1371 | 1371 | 4273 | 3756 | 3756 | 362 | 563 | 563 |
| 24-Aug-18 | 692 | 1155 | 692 | 4114 | 3651 | 4114 | 320 | 503 | 320 |
| 29-Aug-18 | 739 | 1207 | 1207 | 3995 | 3526 | 3526 | 336 | 524 | 524 |
| 01-sept-18 | 725 | 1271 | 725 | 4487 | 3941 | 4487 | 331 | 545 | 331 |
| 13-sept-18 | 782 | 1291 | 1291 | 4103 | 3594 | 3594 | 352 | 556 | 556 |

Table S2. Correlations between distance metrics for all the rainfall events. Absolute values equal or over 0.60 are in bold.

| | | $D_{HILLS}$ | $D_{HILLS}$ | $D_{STREAM}$ | $D_{STREAM}$ | $D_{HAND}$ | $D_{HAND}$ | $D_{HILLS}$ | $D_{STREAM}$ | $D_{HAND}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | River network | *Wet* | *Dry* | *Wet* | *Dry* | *Wet* | *Dry* | *Composite* | *Composite* | *Composite* |
| $D_{HILLS}$ | *Wet* | - | | | | | | | | |
| $D_{HILLS}$ | *Dry* | **0.97** | - | | | | | | | |
| $D_{STREAM}$ | *Wet* | **0.78** | **0.87** | - | | | | | | |
| $D_{STREAM}$ | *Dry* | **0.76** | **0.85** | **1.00** | - | | | | | |
| $D_{HAND}$ | *Wet* | **0.95** | **0.95** | **0.70** | **0.68** | - | | | | |
| $D_{HAND}$ | *Dry* | **0.87** | **0.95** | **0.79** | **0.75** | **0.94** | - | | | |
| $D_{HILLS}$ | *Composite* | 0.51 | 0.57 | 0.42 | 0.38 | 0.57 | **0.63** | - | | |
| $D_{STREAM}$ | *Composite* | **0.72** | **0.77** | **0.92** | **0.93** | **0.61** | **0.65** | 0.04 | - | |
| $D_{HAND}$ | *Composite* | 0.28 | 0.36 | 0.22 | 0.18 | 0.40 | 0.48 | **0.96** | -0.18 | - |

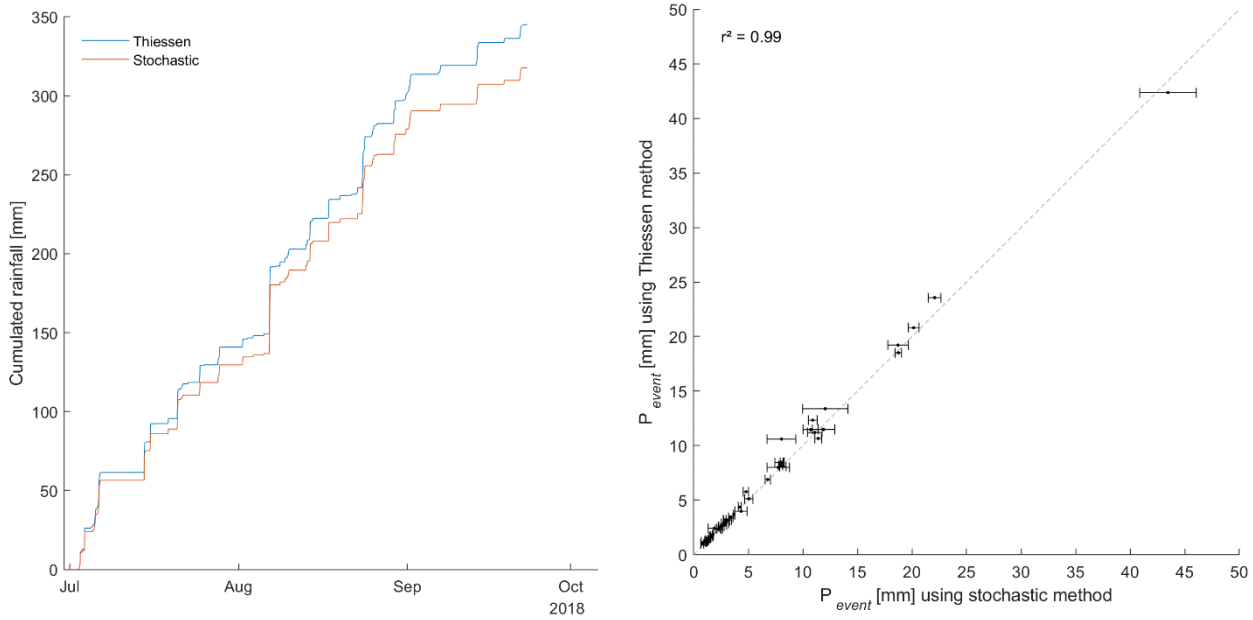


Figure S7: Deviation between the two spatial rainfall interpolation methods used in this paper, in terms of cumulated rainfall (left) and per event (right).

Table S3. For the 23 events measured by the full network setup: number of stations wrong by a factor 2 compared to the average of all the stations.

| P event No. | Number of stations wrong by a factor 2 |
|---|---|
| 16 | 9 |
| 17 | 0 |
| 18 | 0 |
| 20 | 4 |
| 21 | 7 |
| 23 | 11 |
| 24 | 1 |
| 25 | 0 |
| 26 | 0 |
| 28 | 4 |
| 29 | 2 |
| 30 | 0 |
| 31 | 0 |
| 32 | 7 |
| 33 | 0 |
| 34 | 1 |
| 35 | 0 |
| 36 | 2 |
| 37 | 2 |
| 38 | 4 |
| 39 | 11 |
| 40 | 0 |
| 41 | 1 |

Table S4. For the 23 events measured by the full network setup: number of events for which the station is wrong by a factor 2 compared to the average of all the stations.

| Station No. | Number of events for which the station is wrong by a factor 2 |
|---|---|
| 1 | 8 |
| 2 | 2 |
| 3 | 5 |
| 4 | 5 |
| 5 | 3 |
| 6 | 4 |
| 7 | 8 |
| 8 | 6 |
| 9 | 7 |
| 10 | 4 |
| 11 | 7 |
| 12 | 7 |