FEH changes for Peak Flows V14

Overview of changes based on current methods and descriptors

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Contents

1. Executive Summary

This report serves as an appendix to the Peak Flows V14 release notes, expanding on the differences between Version 13 and Version 14 in the context of FEH methods: single-site analysis, donor adjustment to *QMED* estimates, and pooled flood frequency estimates (Vesuviano et al., 2025). This includes an analysis of the new data at a selection of approximately 1500 ungauged locations across Great Britain.

It does not include or directly discuss the new catchment descriptors included with V14: $FARL_{2015}$, $SAAR_{9120}$, $URBEXT_{2015}$, $BFIHOST19_{SCALED}$. These are discussed in a separate report, available through the FEH website (Vesuviano et al., 2025).

It also focuses on differences in the data. For the purpose of this report, the new FEH 2025 Statistical Method is used on both the V13 and V14 datasets; in general, we recommend using the new method on V14 and above, and older methods on V13 and below. For all relevant applications, gauging stations in V13 are defined to have identical values of the new catchment descriptors to those in V14.

Overall, there were some small changes across the UK in growth curves and pooling-groups due to longer records on average, a small number of new stations and the reclassifying of a small number of stations as “Suitable for Pooling”. Single-site analysis was typically impacted most by new peak flow values above AMAX3, or the inclusion or rejection of a large number of AMAX values as part of the period of record review.

The ungauged locations selected are representative of the gridded river network across Great Britain (covering all combinations of *AREA*, $BFIHOST_{19}$, *SAAR*, *FARL* and *FPEXT*), and as such predominantly consists of very small catchments, unlike the NRFA Peak Flow dataset. This leads to very different patterns in the differences between the results using V13 and V14 as potential donors and pooling-group members on the ungauged dataset. This is to be expected.

2. Differences in catchment descriptors

Between V14 and V13, there were few unexpected changes found in FEH catchment descriptors. As such, there are essentially no changes in the catchment-descriptor estimates of *QMED*, or any urban adjustments. See the Peak Flows V14 note for more details (NRFA, 2025). The main change is in the difference of method being recommended: see the FEH 2025 Statistical Method Update (Vesuviano and Griffin, 2025) for more details.

3. Differences in single-site analysis

This section documents changes in single-site (not Enhanced single-site) analysis of FEH statistics.

Between V13 and V14, most stations gained one extra year of record (as expected), though a small number of stations had some periods excluded or un-excluded from AMAX analysis due to a period of record review or similar. These are documented in the main NRFA Peak Flow V14 release note.

3.1 Changes in record length

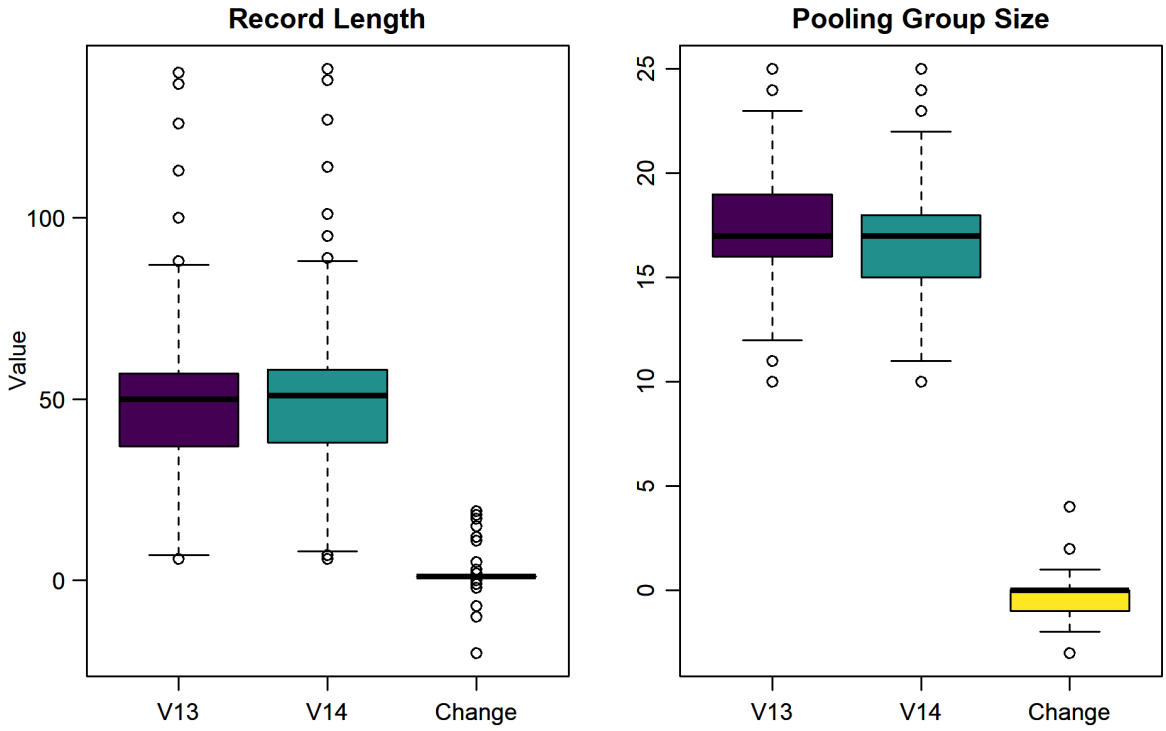

Figure 1: Boxplots showing percentage change in record length and pooling-group size, split by NRFA version.

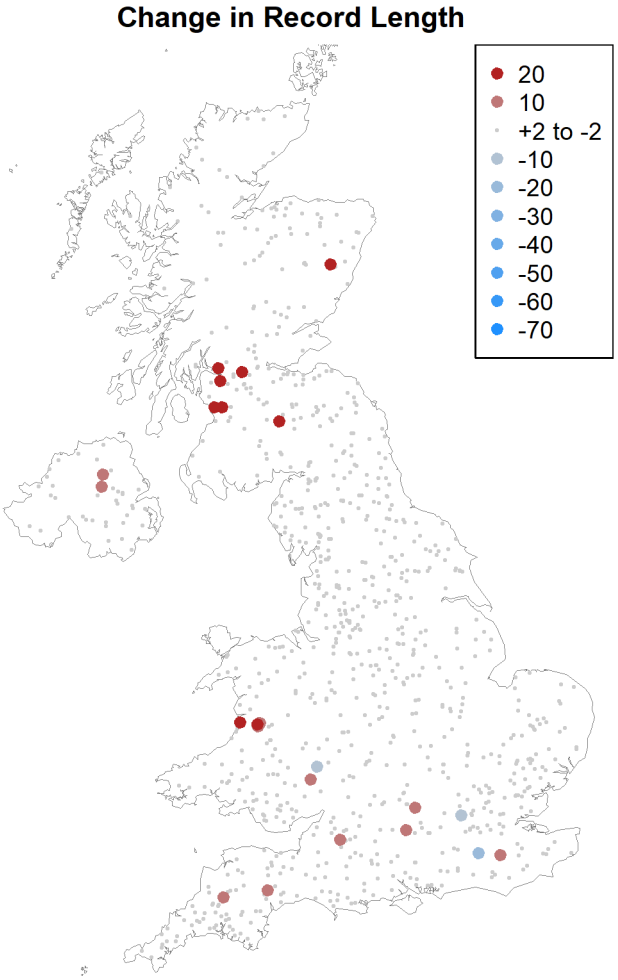

Figure 2: Change in record length (years) across NRFA stations.

3.2 Changes in gauged *QMED*

See Figure 3 for changes in gauged *QMED* between V13 and V14. Specific changes (greater than 10%) are shown in Figure 5, and in the V14 release note.

3.3 Changes in gauged (single-site) growth curve

The following figures show changes in the FEH growth curve, XT, which is equal to the flood frequency curve, QT, divided by QMED, based just on the scale and shape parameters of the fitted GLO distribution. They are linked by $Q_T = QMED \times X_T$. Changes in the growth curve are shown summarised in boxplots in Figure 3 and illustrated spatially (for changes above 10%) in Figure 4.

The gauged changes in growth curve are mostly down to notable new AMAX values (above AMAX3) which can affect the tails of the distribution, as well as

rejections or introductions of periods of station records. Thirdly, rating changes enacted on the whole AMAX series can lead to notable changes in the flood frequency curve, especially if flow derivations increase in the upper tail under the new rating. These major changes are justified in the main NRFA V14 release note.

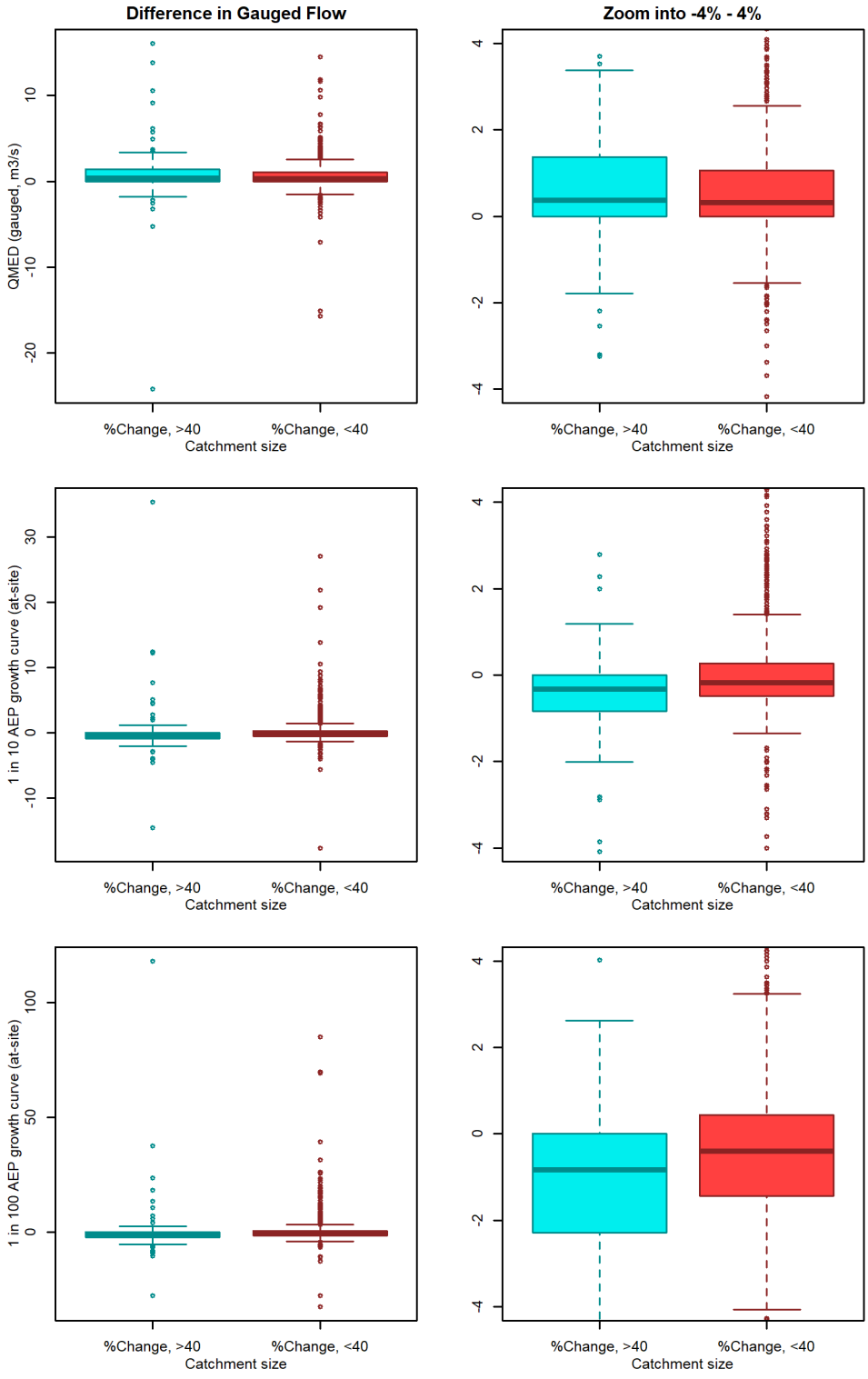

Figure 3: Box plots of differences in gauged *QMED* and growth curves, split by catchment size (Small < 40 km^2).

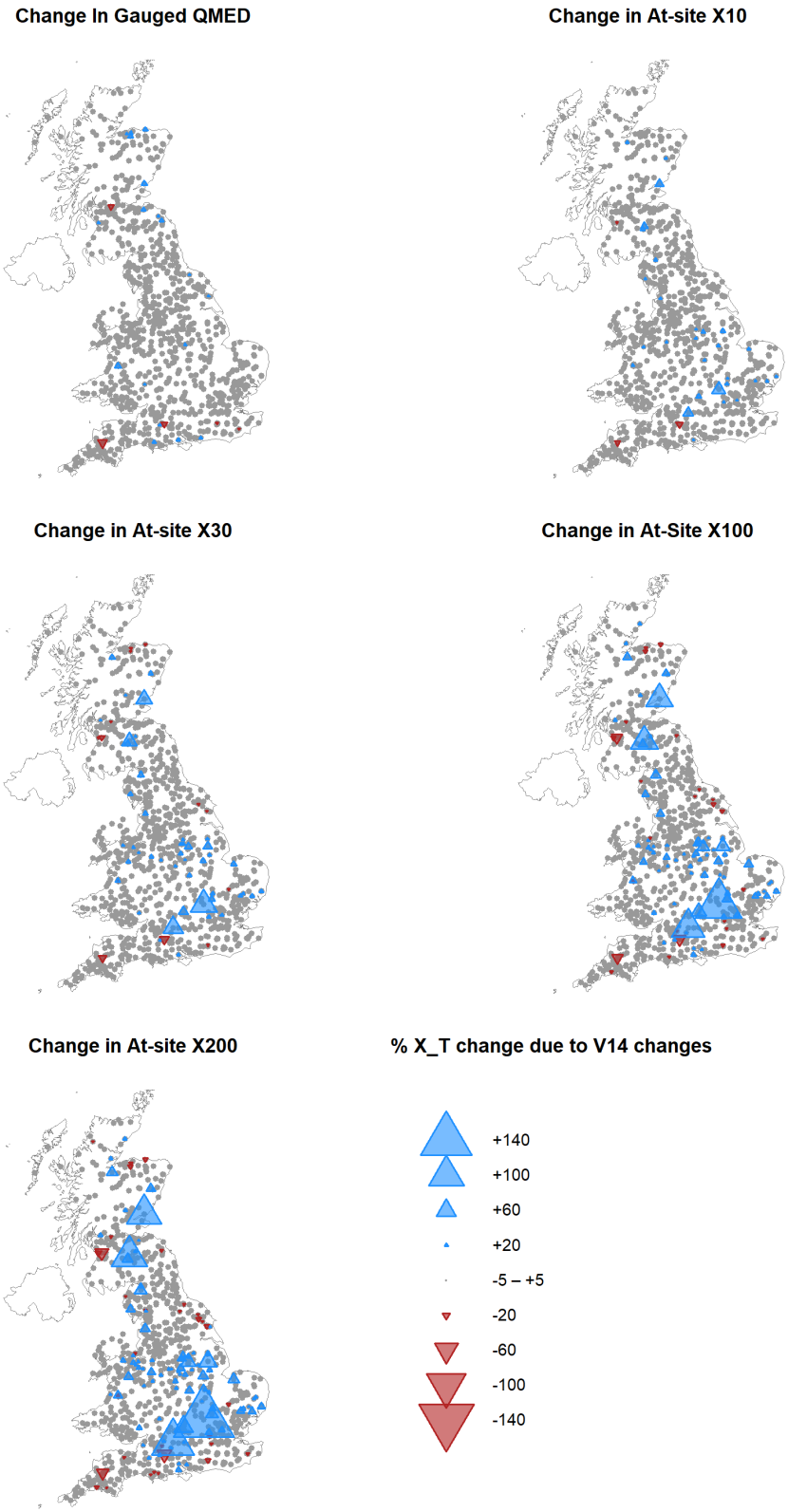

Figure 4: Changed in at-site (single-site) estimates of flood frequency growth curves at NRFA stations.

3.4 Changes in flood frequency curve

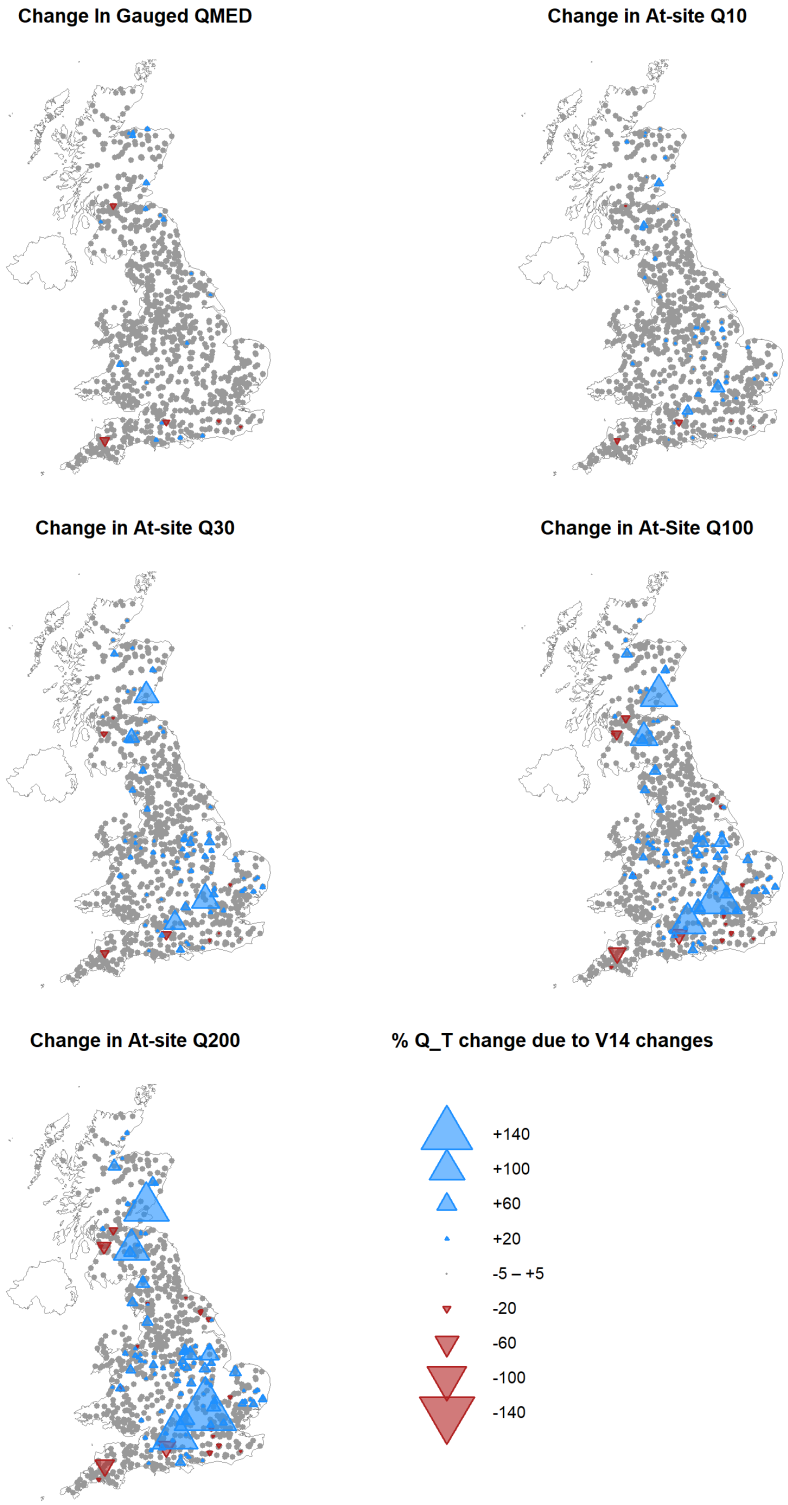

Figure 5: Changed in at-site (single-site) estimates of flood frequency return levels at NRFA stations.

Changes in flood frequency exceeding 10% can be seen across the network in Figure 5.

Big changes in the gauged flood frequency curves are all a combination of the changes already documented with regards to changes in gauged *QMED* and changes in the growth curve. There is no obvious spatial pattern of compounding changes in both *QMED* and X_T.

4. Differences in Donor adjustment

Donor-adjustment, as developed in WINFAP 5.3 and Vesuviano and Griffin (2025), uses the eight nearest "suitable for *QMED*" stations to improve the $QMED_{CD}$ estimate assuming spatially consistent errors between gauged *QMED* and $QMED_{CD}$. In this report, selected donors are those chosen as default in WINFAP 5.3 without adjustment.

The main changes between donor-adjusted *QMED* at NRFA stations are due to the addition of six new "Suitable for pooling" stations, two new "Suitable for *QMED*" stations, the removal of one Pooling- and two QMED-suitable stations, and changes in gauged *QMED* at existing stations.

Only one station exhibited a change in donor-adjusted QMED above 10%, station 21031, where the closest donor (21035) exhibited a change in QMED of +12% as a result of only having a short record and a large AMAX value.

In the ungauged network, the predominantly small catchments lead to overall small changes in donor-adjusted *QMED*. There were no changes above 10% in donor-adjusted *QMED*.

4.1 Changes in donor-adjusted *QMED*

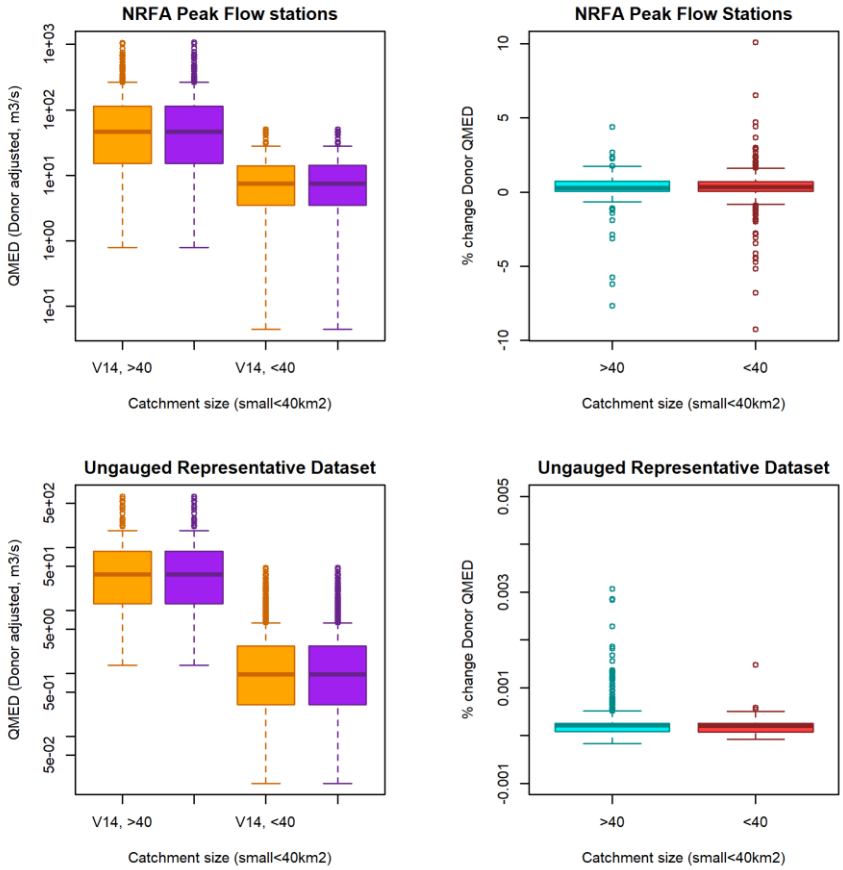

Figure 6: Boxplots highlighting differences between donor-adjusted *QMED* in NRFA stations and ungauged locations.

5. Differences in pooled flood frequency

Pooling uses hydrologically similar catchments to generate a set of at least 500 station-years, which is used to generate weighted average estimates of *L*-moment ratios for calculating return levels. The FEH approach uses the Generalised Logistic distribution to estimate return levels of specified exceedance probabilities.

In the following, default pooling-groups are used as derived using the FEH 2025 Statistical Method in WINFAP 5.3 (Wallingford HydroSolutions, 2025).

Changes in pooling-groups

Table 1 to Table 4 show the ten most common pooled stations in V12.1 and in V13 for the NRFA stations and for the ungauged dataset. Because, even with the small catchments update (Vesuviano et al., 2024), there are very few small catchments in the NRFA dataset, most of the most commonly used stations are small. This is even more true in the ungauged dataset, which leads to a very small variability in the pooling-groups for the smallest catchments. To look beyond this, Table 2 shows the most common pooling-group members for larger NRFA catchments (above 40 km^2), and Table 4 shows this for the ungauged dataset.

The changes between the most common pooling-group members are either due to the addition of new NRFA small catchments, or to the overall increase in average record length leading to small adjustments of pooling-group size.

Table 1: Most commonly "pooled" stations in V13 and V14 for NRFA stations.

V14	% pools	notes	V13	% pools	notes
72007	6.99	Small	72007	7.42	Small
84020	6.99	Not Small	84020	7.10	Not Small
57014	6.77	Not Small	54025	6.99	Not Small
54025	6.66	Not Small	76014	6.88	Not Small
76014	6.66	Not Small	57014	6.77	Not Small
28053	6.44	Not Small	71013	6.77	Small
83010	6.33	Not Small	28053	6.66	Not Small
28082	6.22	Not Small	83010	6.55	Not Small
69044	6.22	Not Small	69044	6.44	Not Small
21017	6.11	Small	21017	6.33	Small
53017	6.11	Not Small	84035	6.33	Small
71013	6.11	Small	28082	6.22	Not Small
84035	6.11	Small	7012	6.22	Small
7012	6.00	Small	27095	6.00	Not Small
27095	5.90	Not Small	48004	6.00	Small
48004	5.90	Small	28035	5.79	Not Small
28035	5.79	Not Small	53017	5.79	Not Small
54011	5.68	Not Small	54011	5.79	Not Small
7011	5.68	Small	84014	5.79	Not Small
39028	5.57	Not Small	54004	5.68	Not Small
44003	5.57	Not Small	63001	5.68	Not Small
44011	5.57	Not Small	39028	5.57	Not Small
63001	5.57	Not Small	48001	5.57	Small
68005	5.57	Not Small	55004	5.57	Not Small
84014	5.57	Not Small	68005	5.57	Not Small

Table 2: Most commonly "pooled" stations in V13 and V14 for NRFA stations with area above 40 km^2.

V14	% pools	V13	% pools
28053	7.62	28053	7.88
28082	7.36	69044	7.62
69044	7.36	28082	7.36
28035	6.85	28035	6.85
54011	6.72	54011	6.85
76014	6.72	76014	6.85
63001	6.59	83010	6.85
68005	6.59	84014	6.85
83010	6.59	54004	6.72
84014	6.59	63001	6.72
39028	6.46	68005	6.59
54004	6.33	25020	6.46
57014	6.33	39028	6.46
25020	6.20	28026	6.33
3002	6.20	53013	6.33
53013	6.20	57014	6.33
15013	6.07	15013	6.20
28026	6.07	3002	6.20
54041	6.07	39025	6.20
71008	6.07	54041	6.20
76021	6.07	71008	6.20
39025	5.94	55026	6.07
84020	5.94	76021	6.07
43014	5.81	84020	6.07
55026	5.81	54038	5.94

Table 3: List of most commonly "pooled" stations in V13 and V14 for ungauged locations.

V14	% pools	V13	% pools
28033	61.61	28033	62.25
27051	58.29	27051	59.82
84035	57.84	84035	59.82
47022	55.79	47022	56.69
45816	54.00	45816	56.43
76011	52.78	76011	53.36
95004	47.02	25019	47.41
25019	46.90	27010	45.55
27073	45.75	49005	42.93
27010	44.15	71003	41.33
49005	42.35	69047	40.05
71003	40.75	106002	39.60
106002	38.64	68021	38.77
69047	38.52	25011	38.71
68021	38.07	91802	38.2
91802	37.75	206006	35.38
25011	37.62	23018	34.48
206006	34.29	7009	34.23
23018	34.10	25003	33.53
25003	32.82	26016	33.08
54022	32.69	54022	33.01
7009	32.50	27081	32.82
26016	32.25	49003	32.50
92002	31.61	92002	31.93
27081	31.54	46005	29.11

Table 4: List of most commonly "pooled" stations in V13 and V14 for ungauged locations with catchment area above 40 km^2.

V14	% pools	V13	% pools
33031	10.95	33031	10.95
27059	10.45	4005	10.45
21014	9.95	27059	9.95
75009	9.95	68005	9.95
40008	9.45	75009	9.95
4005	9.45	76004	9.95
68005	9.45	40008	9.45
76004	9.45	3002	8.96
17001	8.46	17001	8.46
57015	8.46	23017	8.46
71010	8.46	27088	8.46
23017	7.96	34005	8.46
27086	7.96	57006	8.46
3002	7.96	57015	8.46
34005	7.96	58002	8.46
54036	7.96	6012	8.46
55013	7.96	71010	8.46
57006	7.96	83010	8.46
6012	7.96	27086	7.96
76014	7.96	54036	7.96
83010	7.96	66005	7.96
205020	7.46	76014	7.96
27040	7.46	27040	7.46
27088	7.46	33011	7.46
33011	7.46	33019	7.46

5.1 Changes in pooled growth curves

Figure 7 and Figure 8 show changes in pooled growth curve (and donor-adjusted *QMED* for reference) for the NRFA stations (Figure 7) and the ungauged dataset (Figure 8). The overall differences between versions V13 and V14 are very small due to the overall consistency between the two datasets. Figure 9 shows large changes in pooled growth curves for NRFA stations (differences above 10%). Figure 10 shows the same for ungauged catchments. The biggest differences are only seen for the more extreme growth curve values, incurred due to very large AMAX values (above AMAX3) at a small number of stations across the network, highlighted in the main NRFA V14 release note. These large values only impact the upper tail of the flood frequency distribution.

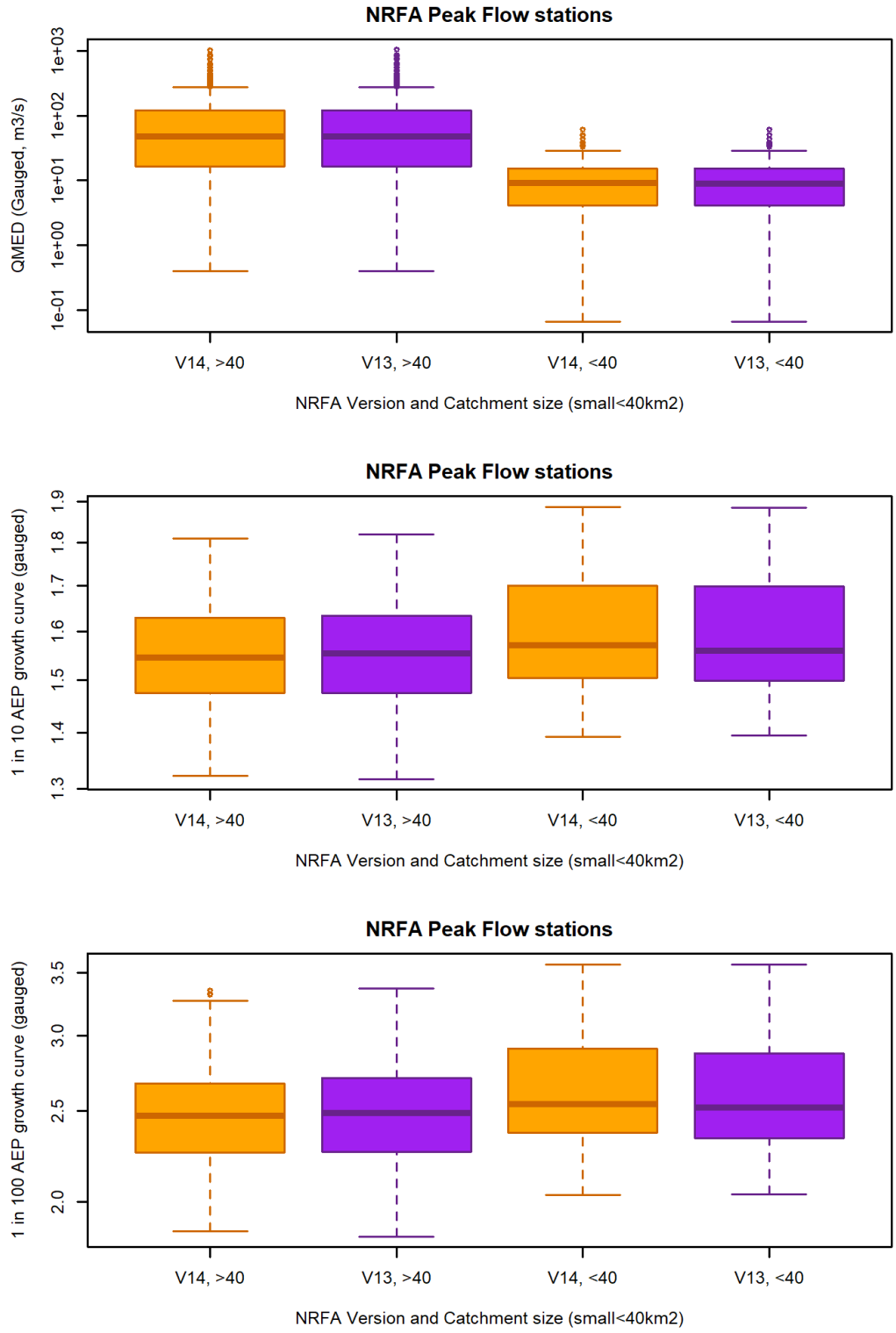

Figure 7: Boxplots of changes in pooled flood frequency growth curves between NRFA Peak Flow versions for NRFA stations, split by catchment size (Small < 40 km^2).

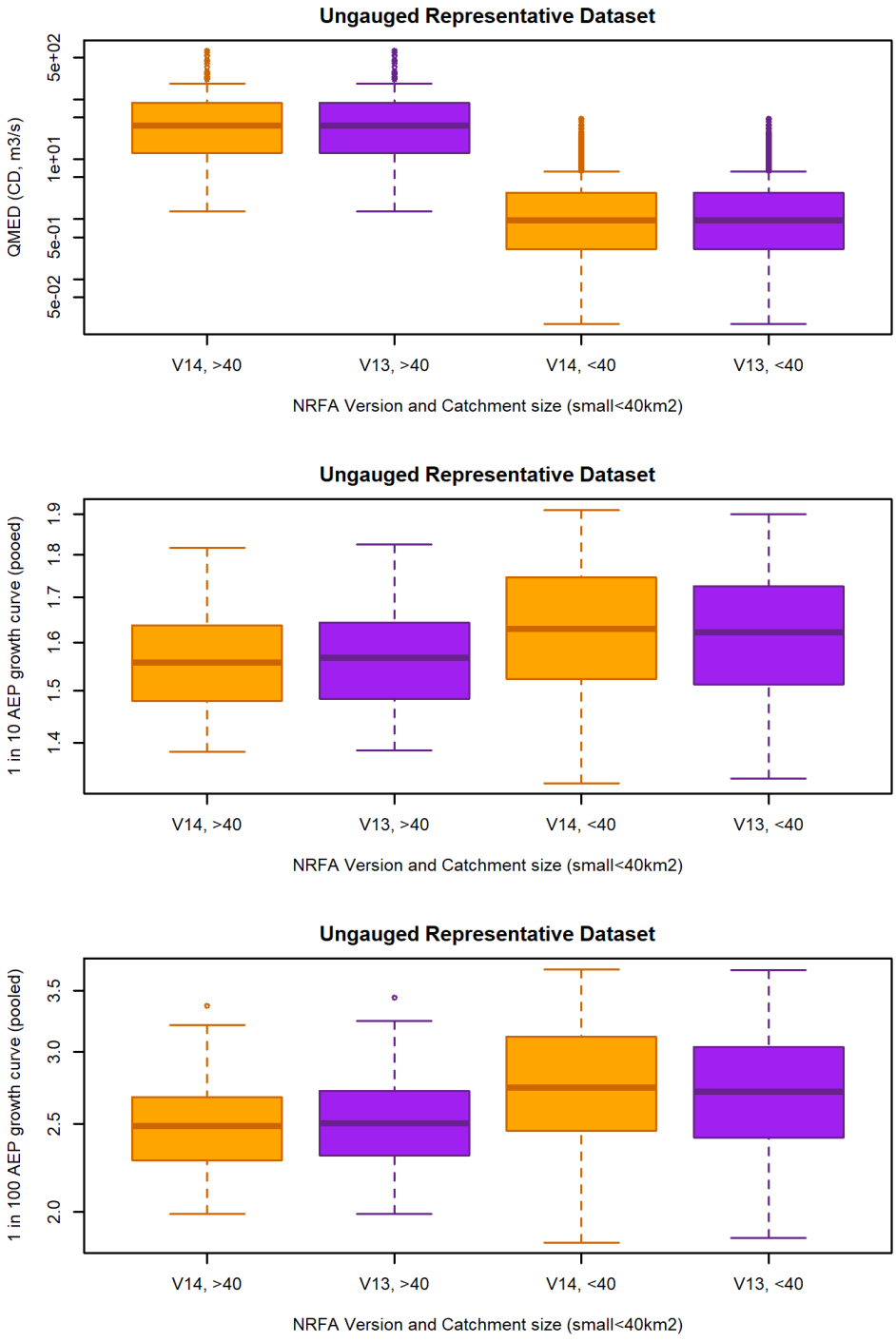

Figure 8: Boxplots of changes in pooled flood frequency growth curves between NRFA Peak Flow versions for ungauged locations, split by catchment size (Small < 40 km^2).

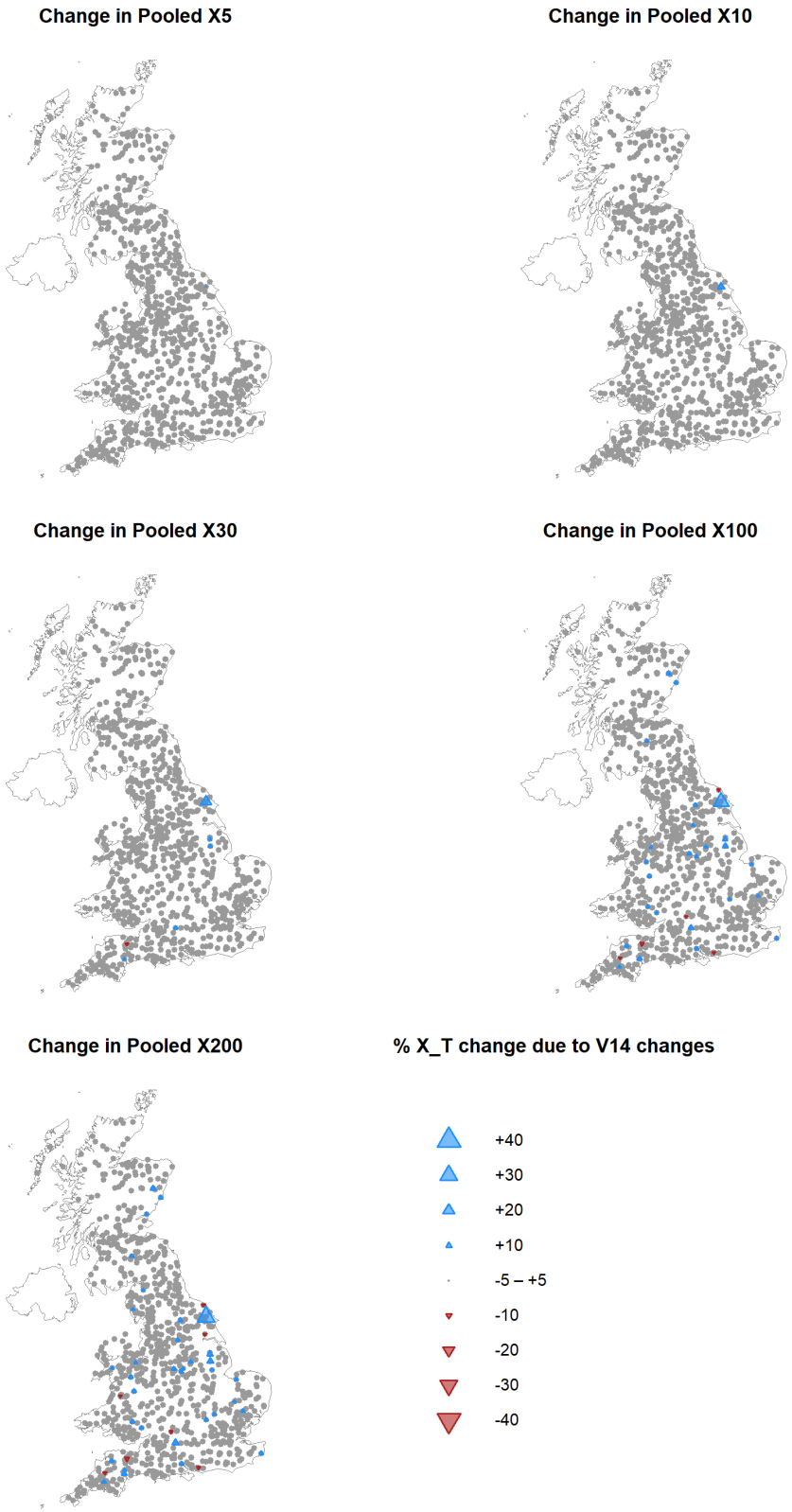

Figure 9: Changed in pooled estimates of flood frequency growth curves at NRFA stations.

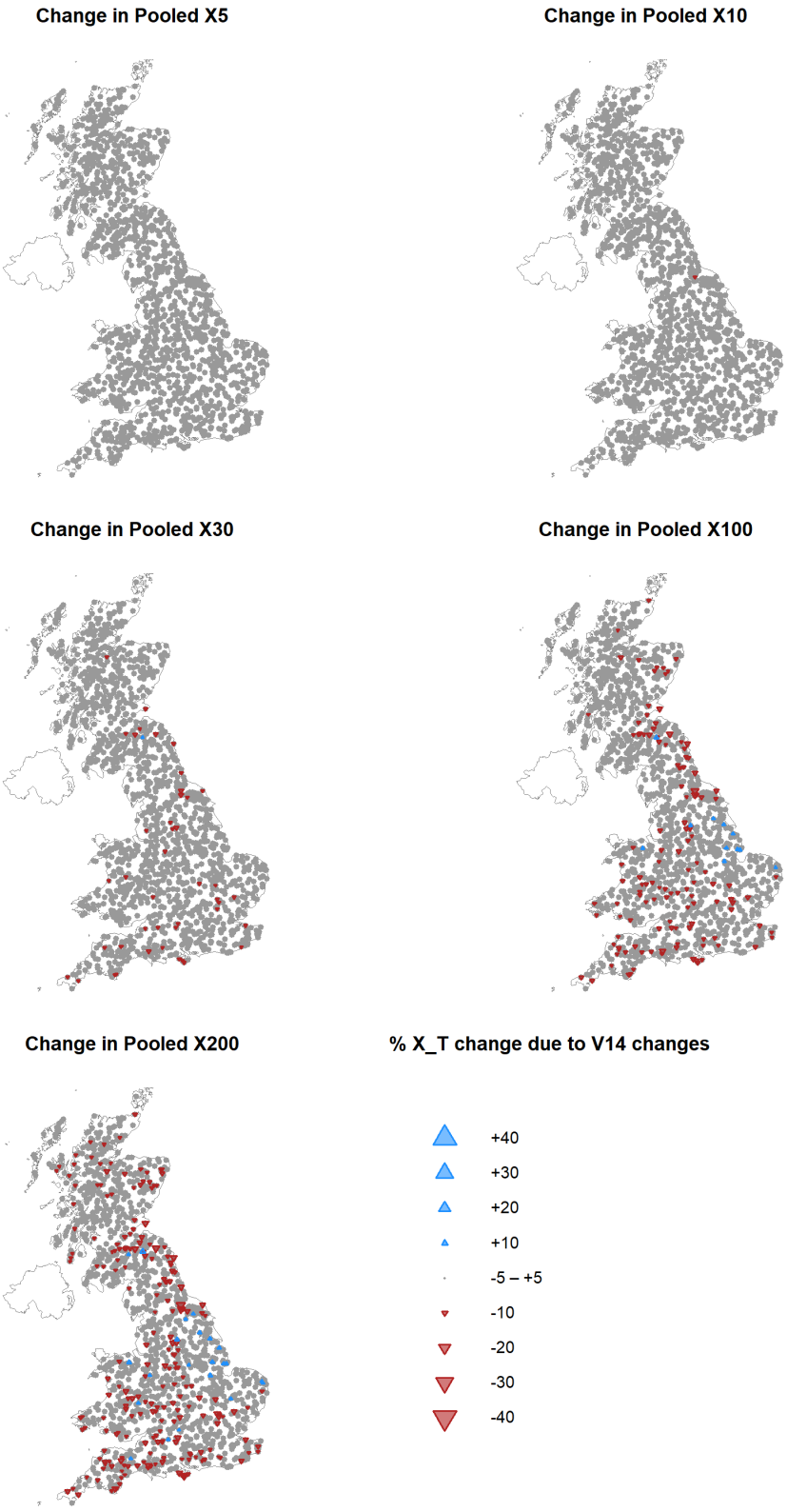

Figure 10: Changed in pooled estimates of flood frequency growth curves at ungauged locations.

5.2 Changes in flood frequency curves

Figure 11 and Figure 12 show changes in pooled return levels (Q_T) (and donor-adjusted *QMED* for reference) for the NRFA stations (Figure 11) and the ungauged dataset (Figure 12). The overall differences between versions V13 and V14 are very small due to the overall high similarity between the two datasets. Figure 13 shows large changes in pooled return levels for NRFA stations (differences above 10%). Figure 14 shows the same for ungauged catchments. The patterns fit with the previous sections regarding the different effects of the growth curve and the estimates of *QMED*.

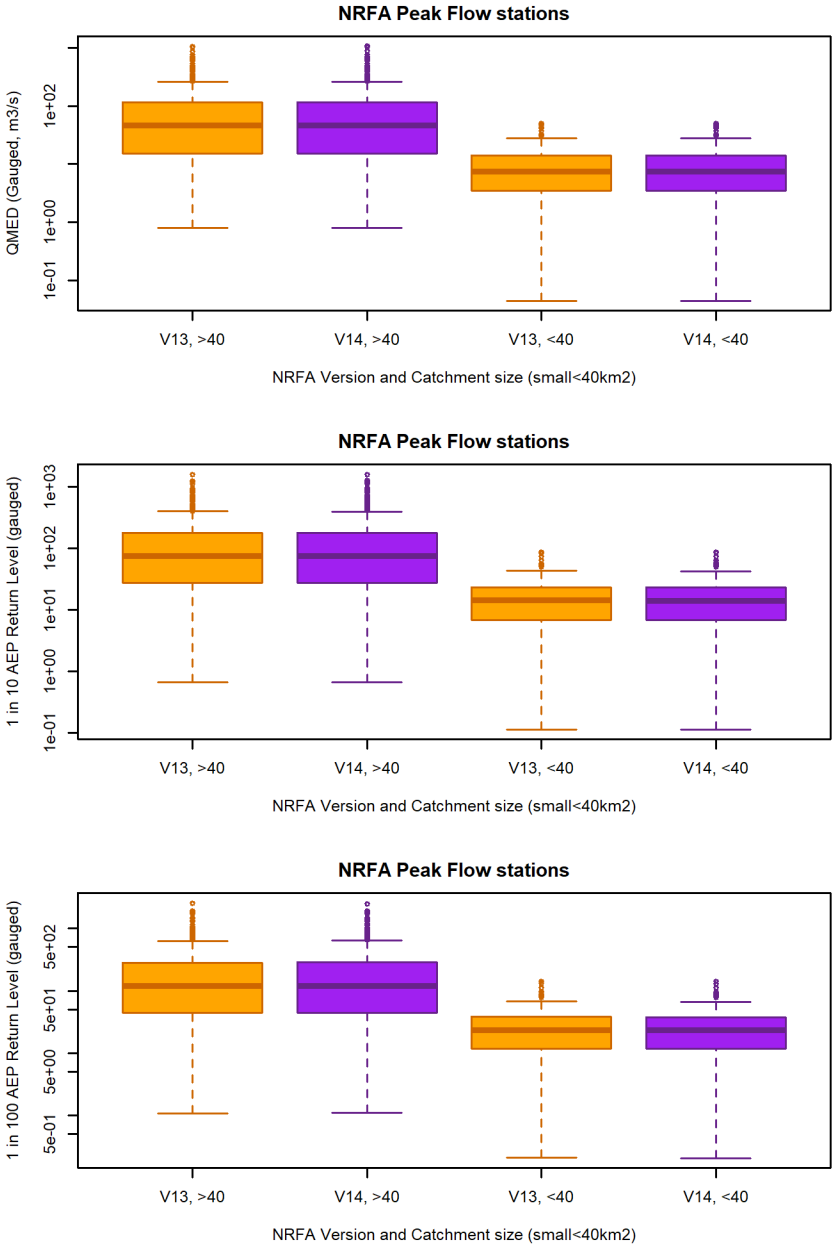

Figure 11: Boxplots of changes in pooled flood frequency return levels between NRFA Peak Flow versions for NRFA stations, split by catchment size (Small < 40 km^2).

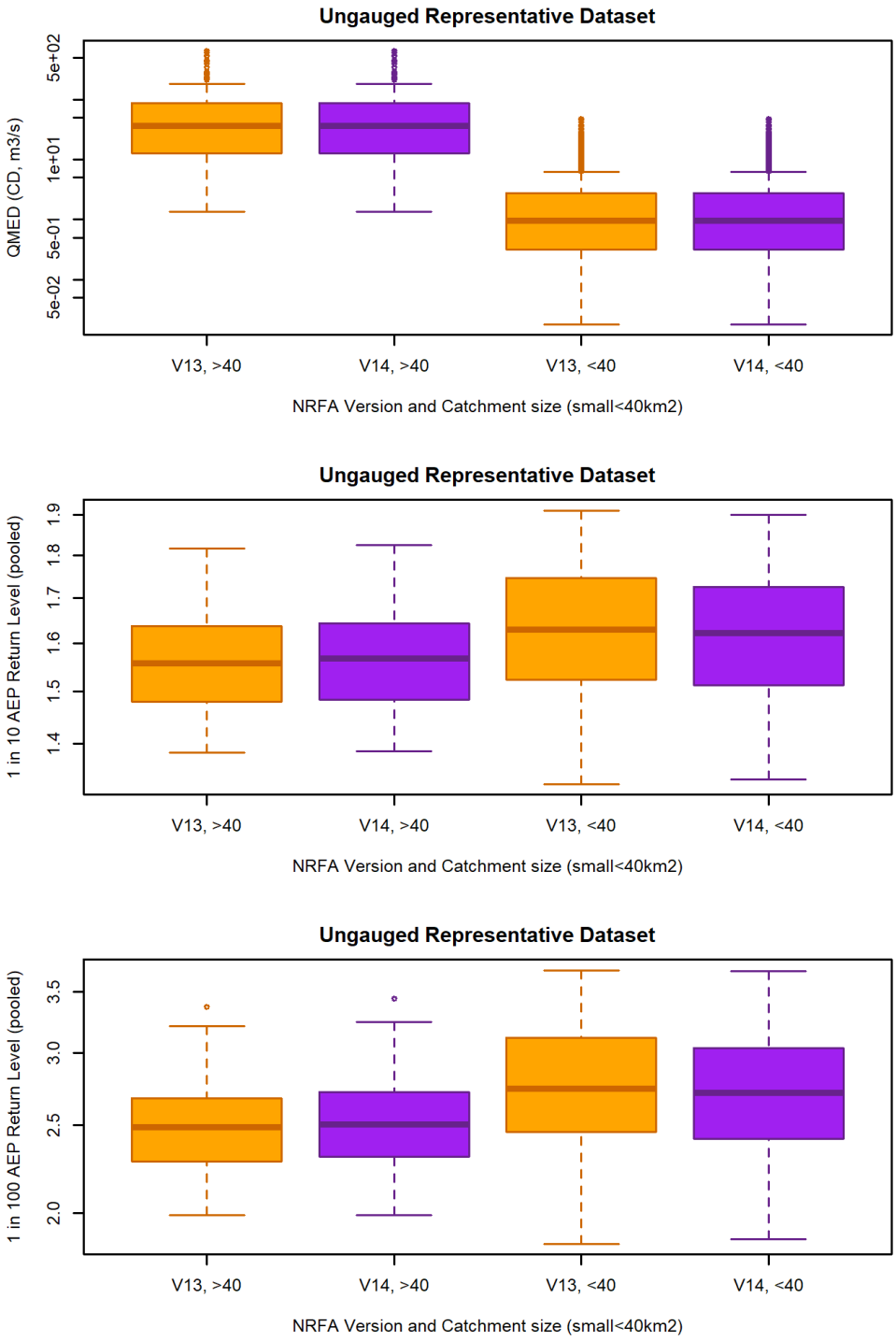

Figure 12: Boxplots of changes in pooled flood frequency return levels between NRFA Peak Flow versions for ungauged locations, split by catchment size (Small < 40 km^2).

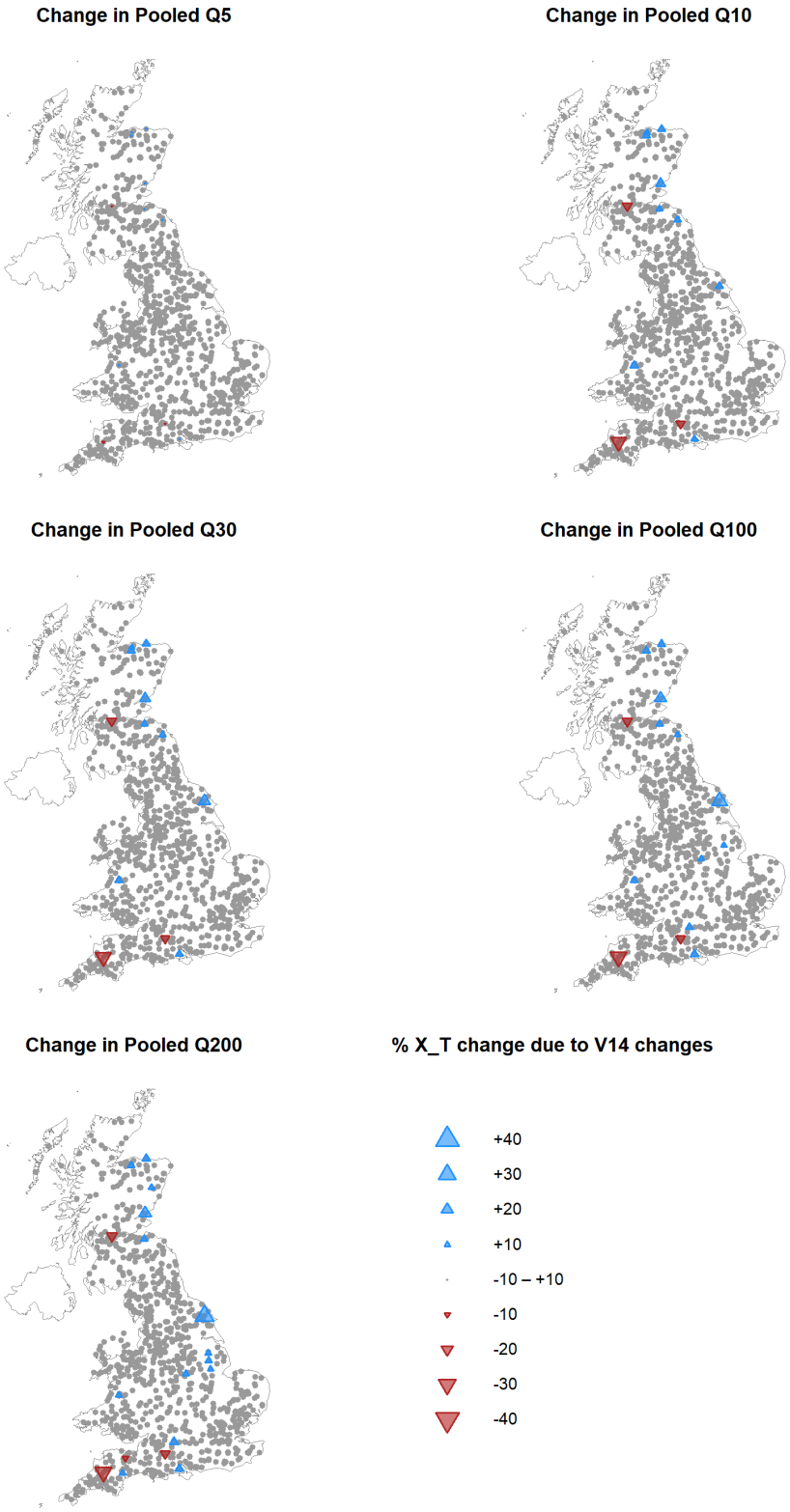

Figure 13: Changes in pooled estimates of flood frequency return levels at NRFA stations.

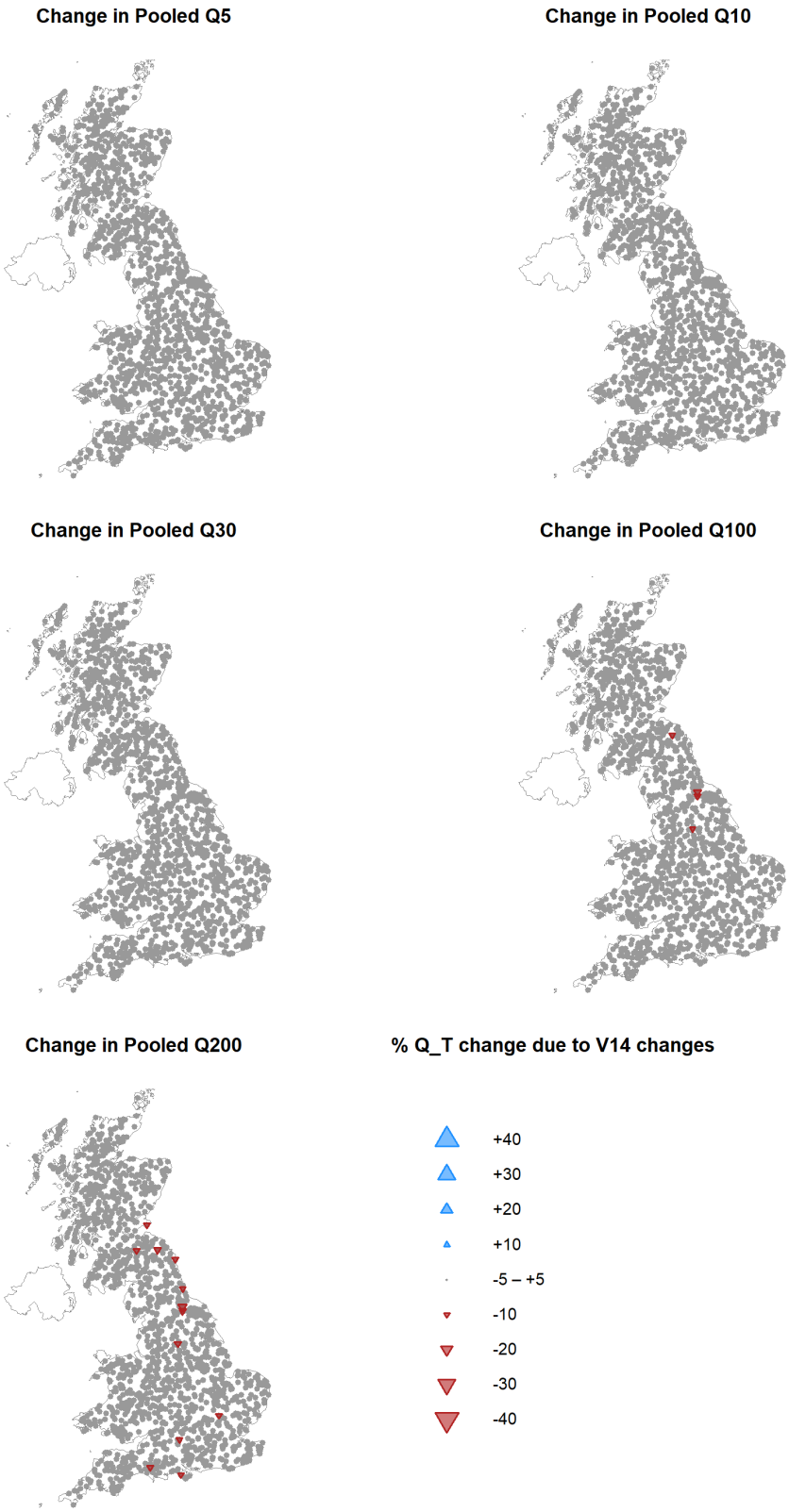

Figure 14: Changed in pooled estimates of flood frequency return levels at ungauged locations.

6. Conclusions

Overall, there were no unexpected or inexplicable changes between the two datasets in terms of flood frequency estimation, with a small number of large changes in the 10-year and 100-year return levels at places that either experienced large AMAX events, or had pooling-group members that experienced such events.

As mentioned above, this report does not include discussion of new catchment descriptors and 'FEH' methods. These are discussed in (Vesuviano et al., 2025) and (Vesuviano and Griffin, 2025).

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reports/review-of-methodology-for-estimating-flood-peaks-and-hydrographs-for-small-catchments [Last Accessed: 2025-08-16]. Environment Agency, Bristol.

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Distribution of catchment descriptors in ungauged dataset

Although this report does not go into the derivation of the ungauged dataset in-depth (can be requested from the FEH team), Figure 15 and Figure 16 show the distribution several catchment descriptors for the IHDTM river network in Great Britain.

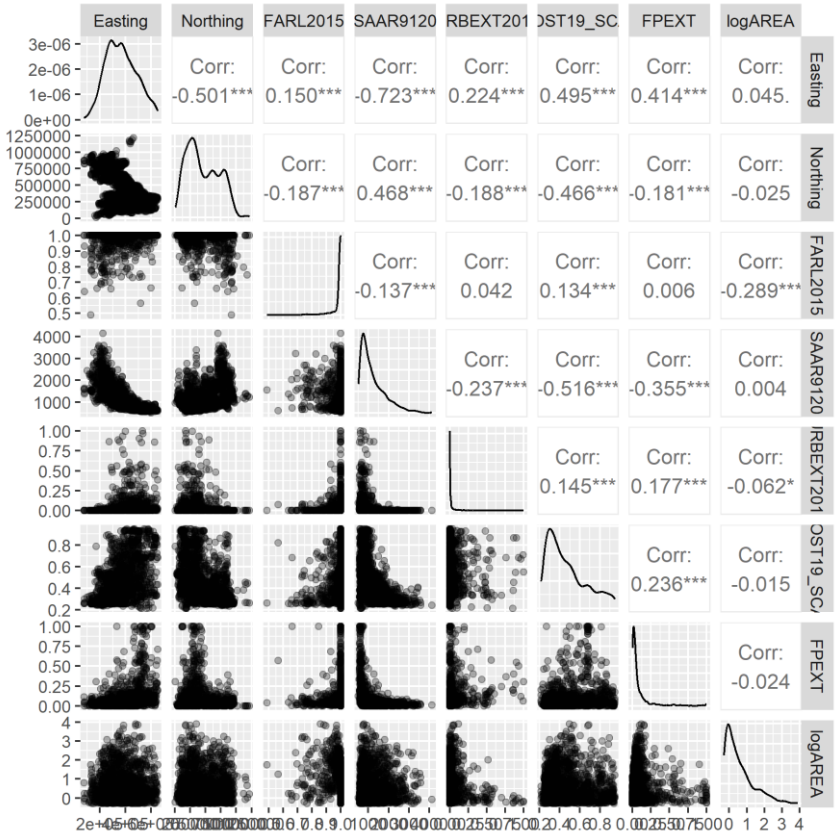

Figure 15: Distribution of catchment descriptors across the IHDTM river network in Great Britain.

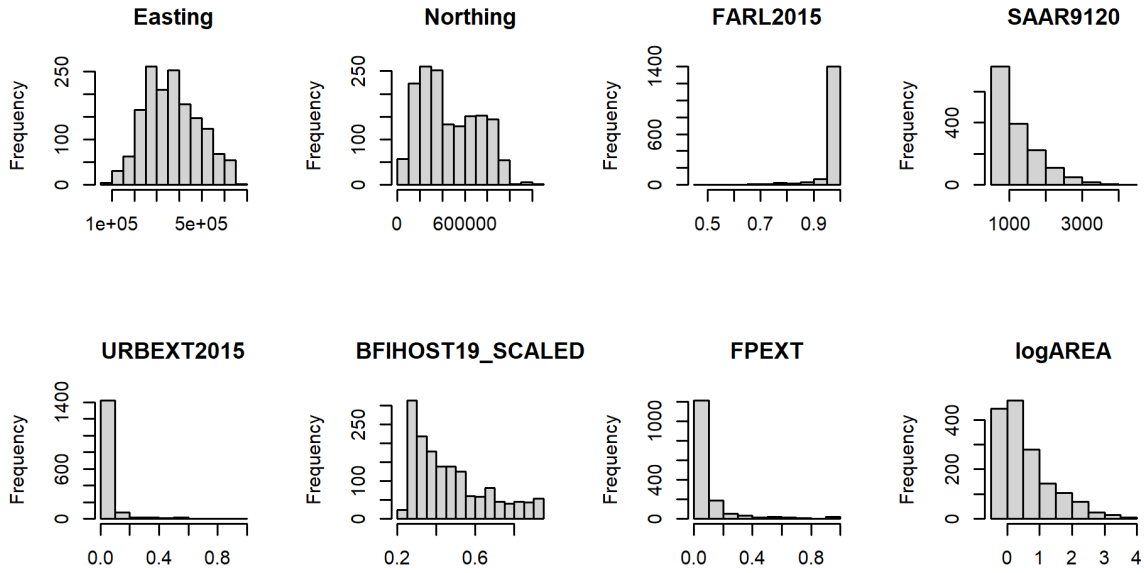

Figure 16: Distribution of catchment descriptors in the Representative Ungauged Dataset

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