

Supplementary information: Continental regional flood frequency analysis: combining enhanced datasets and a Bayesian framework

Table S1: Catchment attribute description (130 attributes)

	<i>Covariates</i>	<i>Description</i>
1	catch_lat	Unit catchment centroid latitude
2	catch_lon	Unit catchment centroid longitude
3	centroid_lat	Latitude of centroid of upstream area
4	centroid_lon	Longitude of centroid of upstream area
5	SLPmean	River slope mean
6	River_slope	River slope
7	log_drainage_area	log10 of upstream drainage area
8	log_drainage_length	log10 of sum of upstream drainage length
9	log_river_length	log10 of length of drainage from station to Network outlet
10	log_dam_area	log10 of sum of upstream area protected by dams based on GOODDS dataset
11	RD	River Depth
	Source: MERIT DEM: Multi-Error-Removed Improved-Terrain DEM (u-tokyo.ac.jp)	
12	Dmean	Mean DEM value
13	Dmin	Minimum DEM value
14	Dmax	Maximum DEM value
15	FDR0	Fractional coverage of flow direction classes—flat area
16	FDR1	Fractional coverage of flow direction classes—east (90°)
17	FDR2	Fractional coverage of flow direction classes—southeast (135°)
18	FDR4	Fractional coverage of flow direction classes—south (180°)
19	FDR8	Fractional coverage of flow direction classes—southwest (225°)
20	FDR16	Fractional coverage of flow direction classes—west (270°)
21	FDR32	Fractional coverage of flow direction classes—northwest (315°)
22	FDR64	Fractional coverage of flow direction classes—north (0°)
23	FDR128	Fractional coverage of flow direction classes—northeast (45°)
	Source: Land-Atmosphere Interaction Research Group at Sun Yat-sen University (bnu.edu.cn)—30s resolution	
24	BS45	Mean base saturation at 45 mm
25	BS91	Mean base saturation at 91 mm
26	BS166	Mean base saturation at 166 mm
27	BS289	Mean base saturation at 289 mm
28	BS493	Mean base saturation at 493 mm
29	BS829	Mean base saturation at 829 mm
30	BS1383	Mean base saturation at 1383 mm
31	BS2296	Mean base saturation at 2296 mm
32	BD45	Mean bulk density at 45 mm
33	BD91	Mean bulk density at 91 mm
34	BD166	Mean bulk density at 166 mm
35	BD289	Mean bulk density at 289 mm
36	BD493	Mean bulk density at 493 mm

37	BD829	Mean bulk density at 829 mm
38	BD1383	Mean bulk density at 1383 mm
39	BD2296	Mean bulk density at 2296 mm
40	CLAY45	Mean clay fraction at 45 mm
41	CLAY91	Mean clay fraction at 91 mm
42	CLAY166	Mean clay fraction at 166 mm
43	CLAY289	Mean clay fraction at 289 mm
44	CLAY493	Mean clay fraction at 493 mm
45	CLAY829	Mean clay fraction at 829 mm
46	CLAY1383	Mean clay fraction at 1383 mm
47	CLAY2296	Mean clay fraction at 2296 mm
48	GRAV45	Mean gravel fraction at 45 mm
49	GRAV91	Mean gravel fraction at 91 mm
50	GRAV166	Mean gravel fraction at 166 mm
51	GRAV289	Mean gravel fraction at 289 mm
52	GRAV493	Mean gravel fraction at 493 mm
53	GRAV829	Mean gravel fraction at 829 mm
54	GRAV1383	Mean gravel fraction at 1383 mm
55	GRAV2296	Mean gravel fraction at 2296 mm
56	SAND45	Mean sand fraction at 45 mm
57	SAND91	Mean sand fraction at 91 mm
58	SAND166	Mean sand fraction at 166 mm
59	SAND289	Mean sand fraction at 289 mm
60	SAND493	Mean sand fraction at 493 mm
61	SAND829	Mean sand fraction at 829 mm
62	SAND1383	Mean sand fraction at 1383 mm
63	SAND2296	Mean sand fraction at 2296 mm
64	SILT45	Mean silt fraction at 45 mm
65	SILT91	Mean silt fraction at 91 mm
66	SILT166	Mean silt fraction at 166 mm
67	SILT289	Mean silt fraction at 289 mm
68	SILT493	Mean silt fraction at 493 mm
69	SILT829	Mean silt fraction at 829 mm
70	SILT1383	Mean silt fraction at 1383 mm
71	SILT2296	Mean silt fraction at 2296 mm
72	AWC_5	Available water capacity in mm/m 50 mm/m
73	AWC_4	Available water capacity in mm/m 75 mm/m
74	AWC_1	Available water capacity in mm/m 150 mm/m
75	AWC_3	Available water capacity in mm/m 100 mm/m
76	AWC_2	Available water capacity in mm/m 125 mm/m
77	AWC_6	Available water capacity in mm/m 15 mm/m
78	DRAINAGE_1	Surface soil drainage classes
79	DRAINAGE_2	Surface soil drainage classes
80	DRAINAGE_3	Surface soil drainage classes
81	DRAINAGE_4	Surface soil drainage classes
82	DRAINAGE_5	Surface soil drainage classes
83	DRAINAGE_6	Surface soil drainage classes

84	OC45	Mean organic carbon fraction at 45 mm
85	OC91	Mean organic carbon fraction at 91 mm
86	OC166	Mean organic carbon fraction at 166 mm
87	OC289	Mean organic carbon fraction at 289 mm
88	OC493	Mean organic carbon fraction at 493 mm
89	OC829	Mean organic carbon fraction at 829 mm
90	OC1383	Mean organic carbon fraction at 1383 mm
91	OC2296	Mean organic carbon fraction at 2296 mm
92	TEXTURE_1	Surface soil texture classes
93	TEXTURE_2	Surface soil texture classes
94	TEXTURE_3	Surface soil texture classes
95	TEXTURE_4	Surface soil texture classes
Source: Copernicus, Product User Manual Land Cover 100m V2.0 (copernicus.eu)		
96	LULC1	Permanent water bodies
97	LULC2	open/closed forest
98	LULC3	Herbaceous vegetation, moss and lichen
99	LULC4	Herbaceous wetland
100	LULC5	Cultivated and managed vegetation/agriculture (cropland)
101	LULC6	Shrubs
102	LULC7	Urban/built up
103	LULC8	Bare/sparse vegetation
104	LULC9	Snow and Ice
105	LULC10	Open/closed forest, evergreen needle leaf
106	LULC11	Open/closed forest, evergreen, broad leaf
107	LULC12	Open/closed forest, deciduous needle leaf
108	LULC13	Open/closed forest, deciduous broad leaf
Source: Historical climate data — WorldClim 1 documentation—30s resolution		
109	Srad	Upstream mean solar radiation from 1970 to 2000
110	Vapr	Upstream mean vapor pressure from 1970 to 2000
111	Wind	Upstream mean windspeed from 1970 to 2000
112	mean.BIOC_1	Annual mean temperature
113	mean.BIOC_2	Mean diurnal range (mean of monthly (max temp - min temp))
114	mean.BIOC_3	Isothermality (BIO2/BIO7) (×100)
115	mean.BIOC_4	Temperature seasonality (standard deviation ×100)
116	mean.BIOC_5	Max temperature of warmest month
117	mean.BIOC_6	Min temperature of coldest month
118	mean.BIOC_7	Temperature annual range (BIO5-BIO6)
119	mean.BIOC_8	Mean temperature of wettest quarter
120	mean.BIOC_9	Mean temperature of driest quarter
121	mean.BIOC_10	Mean temperature of warmest quarter
122	mean.BIOC_11	Mean temperature of coldest quarter
123	mean.BIOC_12	Annual precipitation
124	mean.BIOC_13	Precipitation of wettest month
125	mean.BIOC_14	Precipitation of driest month
126	mean.BIOC_15	Precipitation seasonality (coefficient of variation)
127	mean.BIOC_16	Precipitation of wettest quarter
128	mean.BIOC_17	Precipitation of driest quarter

129	mean.BIOC_18	Precipitation of warmest quarter
130	mean.BIOC_19	Precipitation of coldest quarter

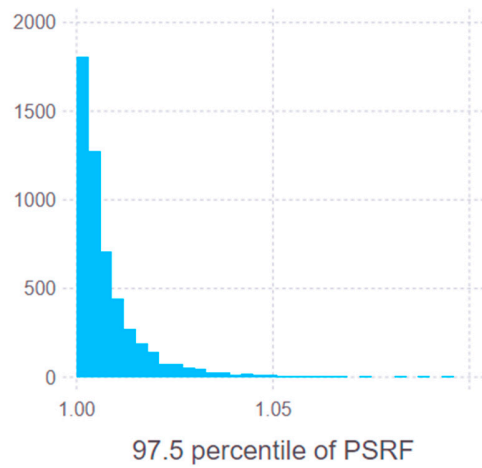


Figure S1: Histogram of the 97.5 percentile of the potential scale reduction factor for the Gelman, Rubin and Brooks diagnostic of MCMC convergence, for all parameters of the BHM model applied to region 9. A threshold of 1.2 is usually used to reject convergence. The diagnostic was calculated using three MCMC chains.

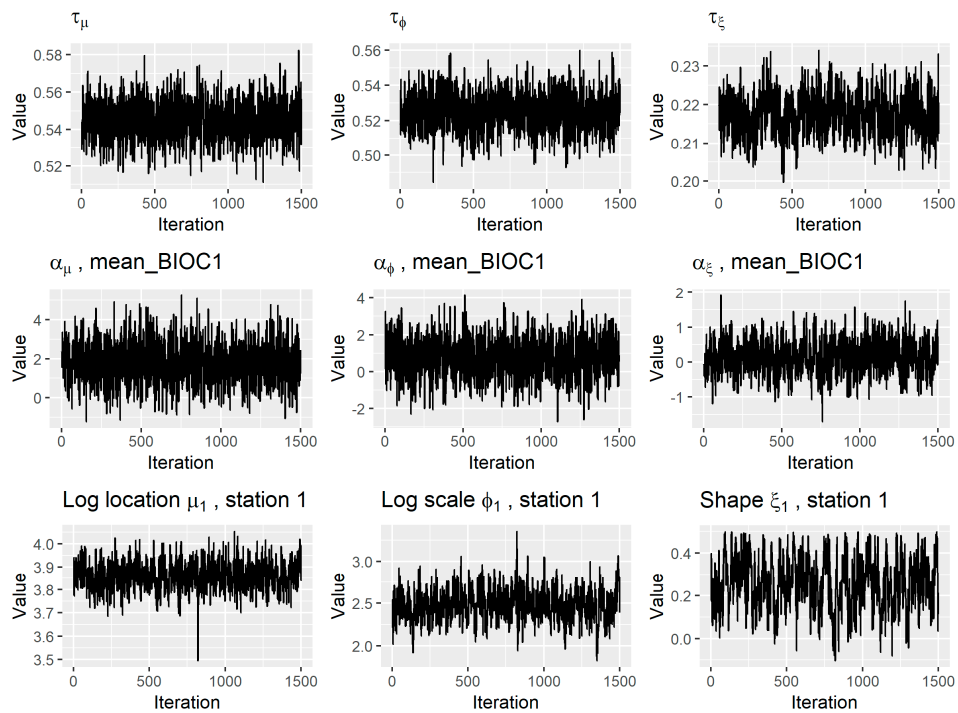


Figure S2: Trace plots for some model parameters for region 9: the three variance parameters (first row), the three coefficients corresponding to covariate mean_BIOC1 (second row) and the GEV parameters for the first station in region 9 (third row).

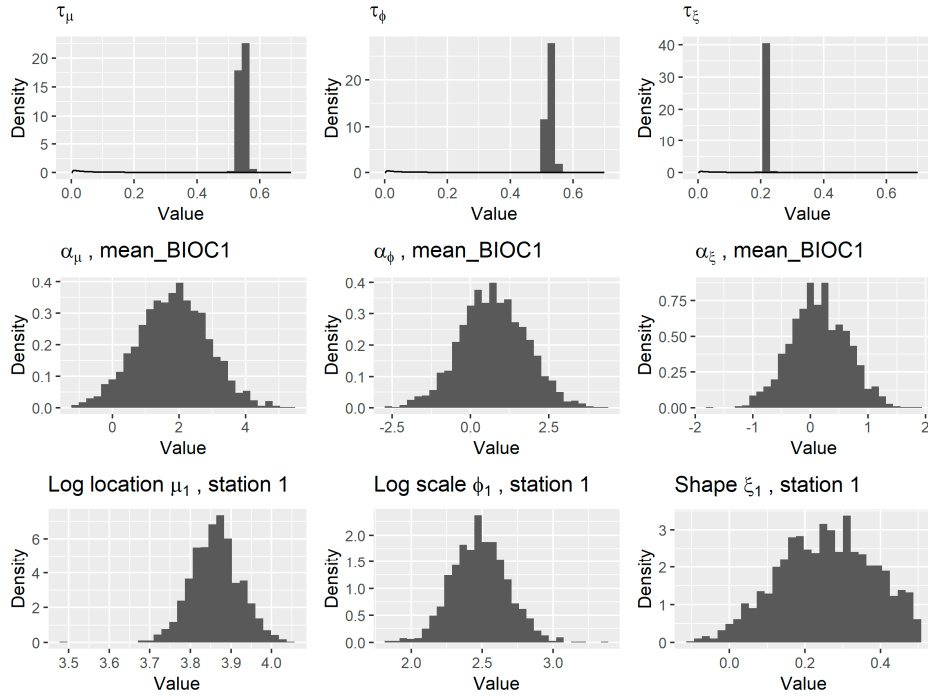


Figure S3: Posterior distributions for the three variance parameters (first row), the three coefficients corresponding to covariate mean_BIOC1 (second row) and the GEV parameters for the first station in region 9 (third row). The prior distributions of the variance parameters are shown in black curves to illustrate their non-informativeness (first row).

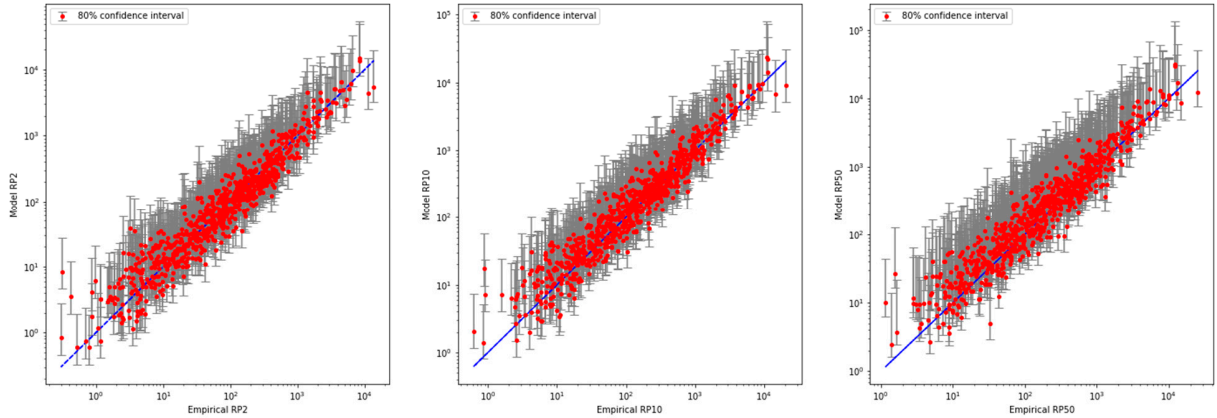
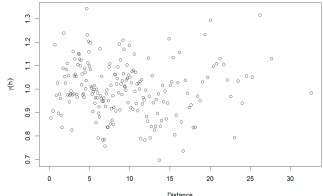
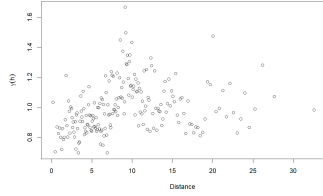
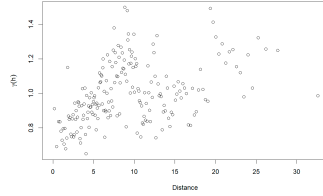
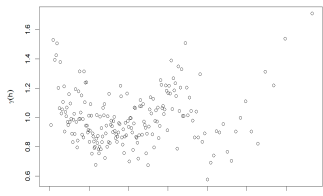
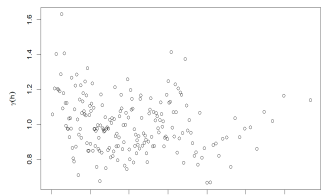
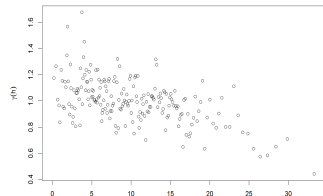
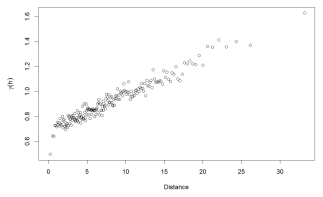
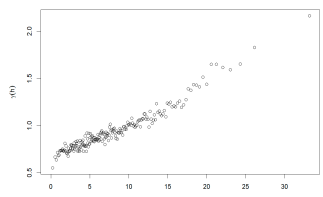
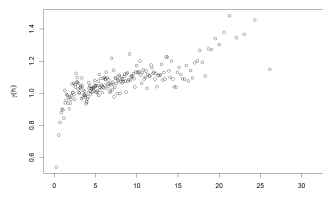
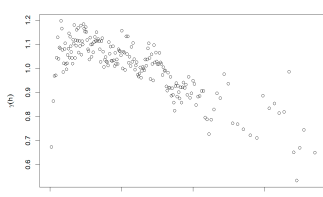
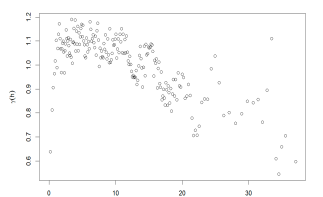
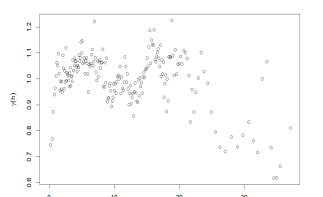
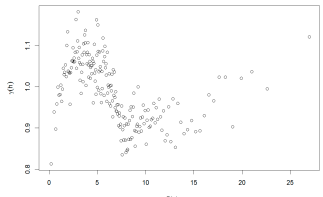
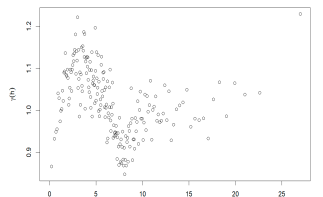
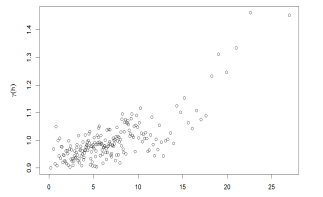
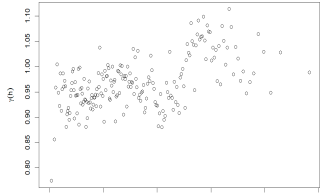
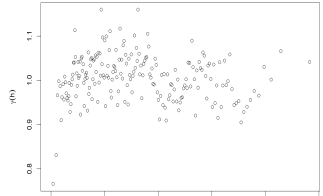
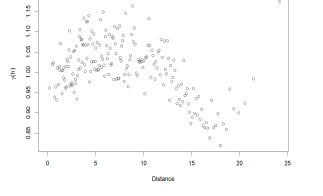
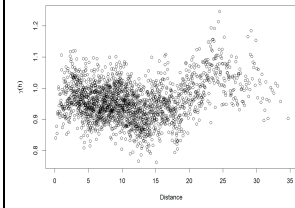
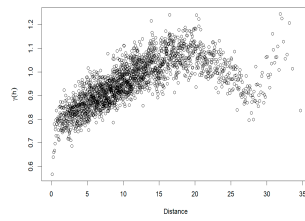
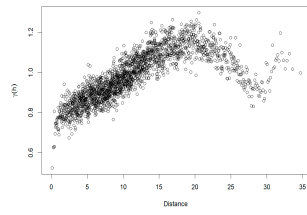


Figure S4: Comparison of the empirical and predicted out-of-sample 2-, 10- and 50-year discharge levels (RP2, RP10 and RP100) for stations in region 9, following the holdout validation approach. Red points show the empirical (x axis) and out-of-sample model median estimates (y axis). The grey error bars show the 80% credible intervals of the model estimates, calculated using the MCMC samples of the GEV parameters. The dashed blue line is the 1-1 diagonal line.

Table S2: Empirical variogram of the regression errors from the BHM model, for the three GEV distribution parameters and regions 5–11.

Region	Location	Scale	Shape
5			
6			
7			
8			
9			
10			



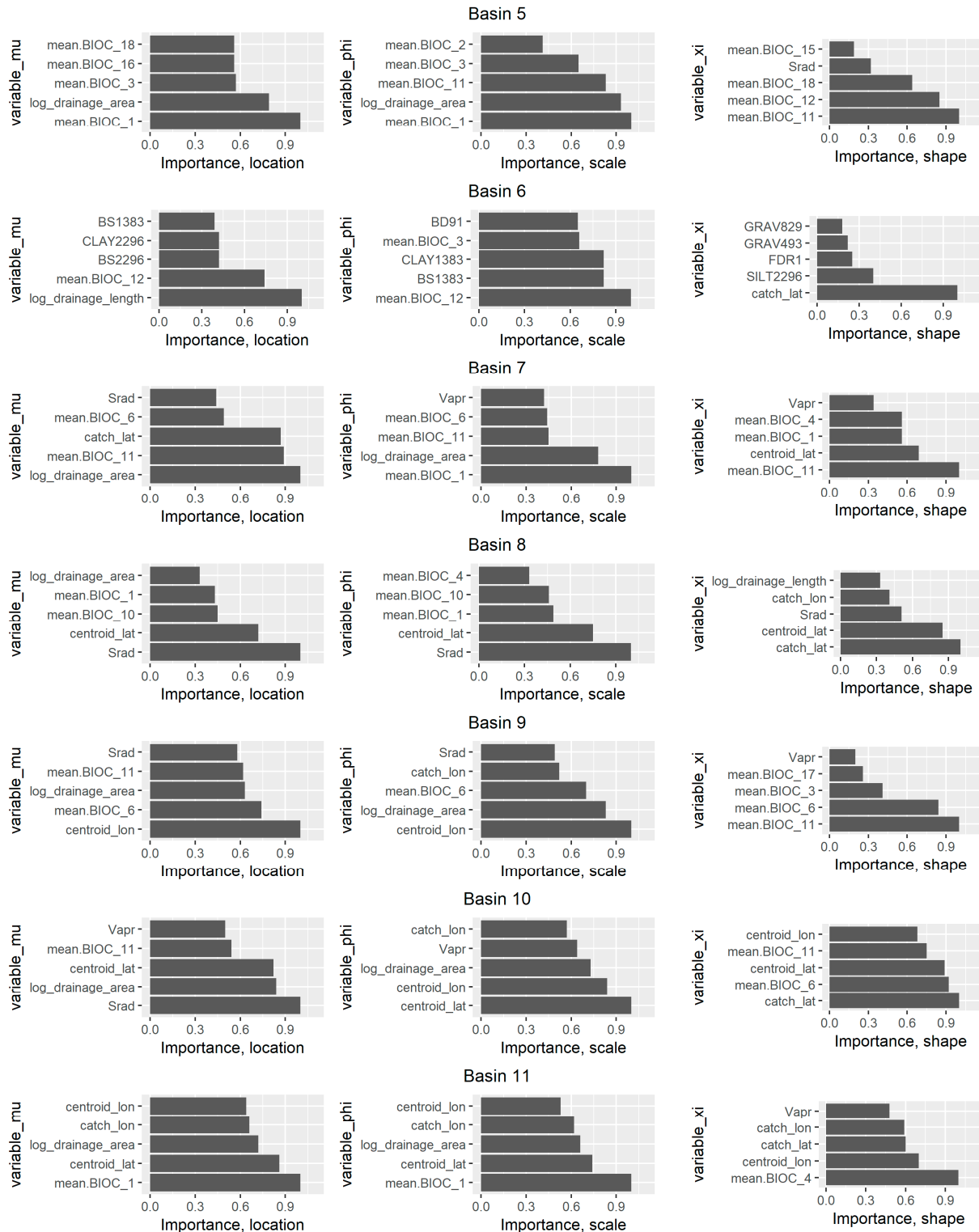


Figure S5: The five most significant covariates for predicting GEV distribution parameters with the BHM model, for each region from 5 to 11. The y axis shows the covariate nomenclatures while the x axis shows the importance score. The score is defined as the absolute value of the corresponding regression coefficients, after regional standardization and the elimination of non-significant covariates.