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REGIONAL FREQUENCY ANALYSIS ON HOURLY RAINFALL EXTREMES IN THE MIDLANDS REGION USING AN L-MOMENT APPROACH

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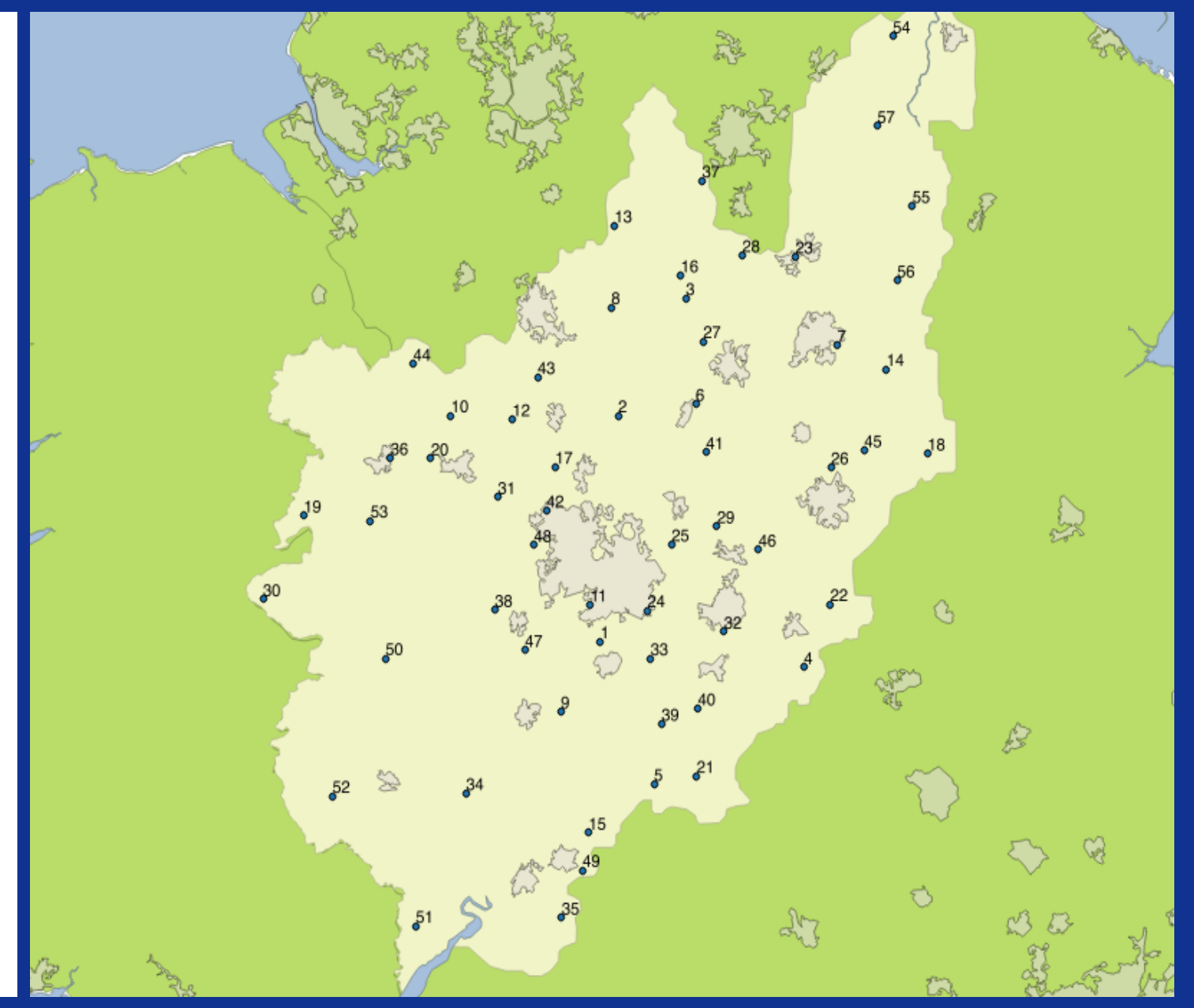
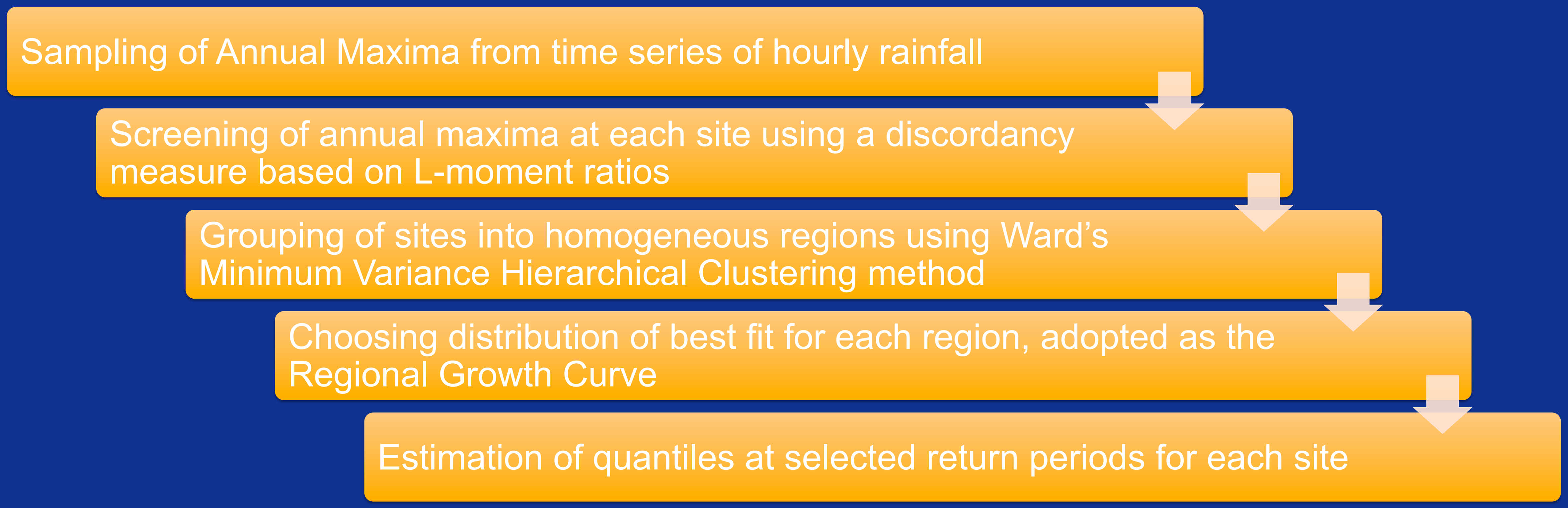
INTRODUCTION

Estimation of the possible magnitude and frequency of extreme rainfall is crucial for the planning of measures to reduce its adverse effects, such as the design of irrigation systems and urban drainage systems, flood protection structures, as well as agricultural and water resources management schemes. Apart from the random and uncertain nature of hydrological phenomena, traditional at-site estimation techniques face the issue of limited duration of records and small samples. Regional Frequency Analysis pools together data from various statistically similar sites enlarging the samples and producing more accurate estimates of extreme rainfall.



Regional Frequency Analysis, using an L-moment approach, is implemented on series of annual maxima on 57 selected sites within the Midlands area. A comparison with the traditional at-site estimation method is carried out, and an assessment of the accuracy and reliability of the estimates is performed using Monte Carlo simulation. Spatial interpolation of extremes at ungauged locations is also implemented in the form of contoured figures.

METHODOLOGY



Sampling of Annual Maxima from time series of hourly rainfall

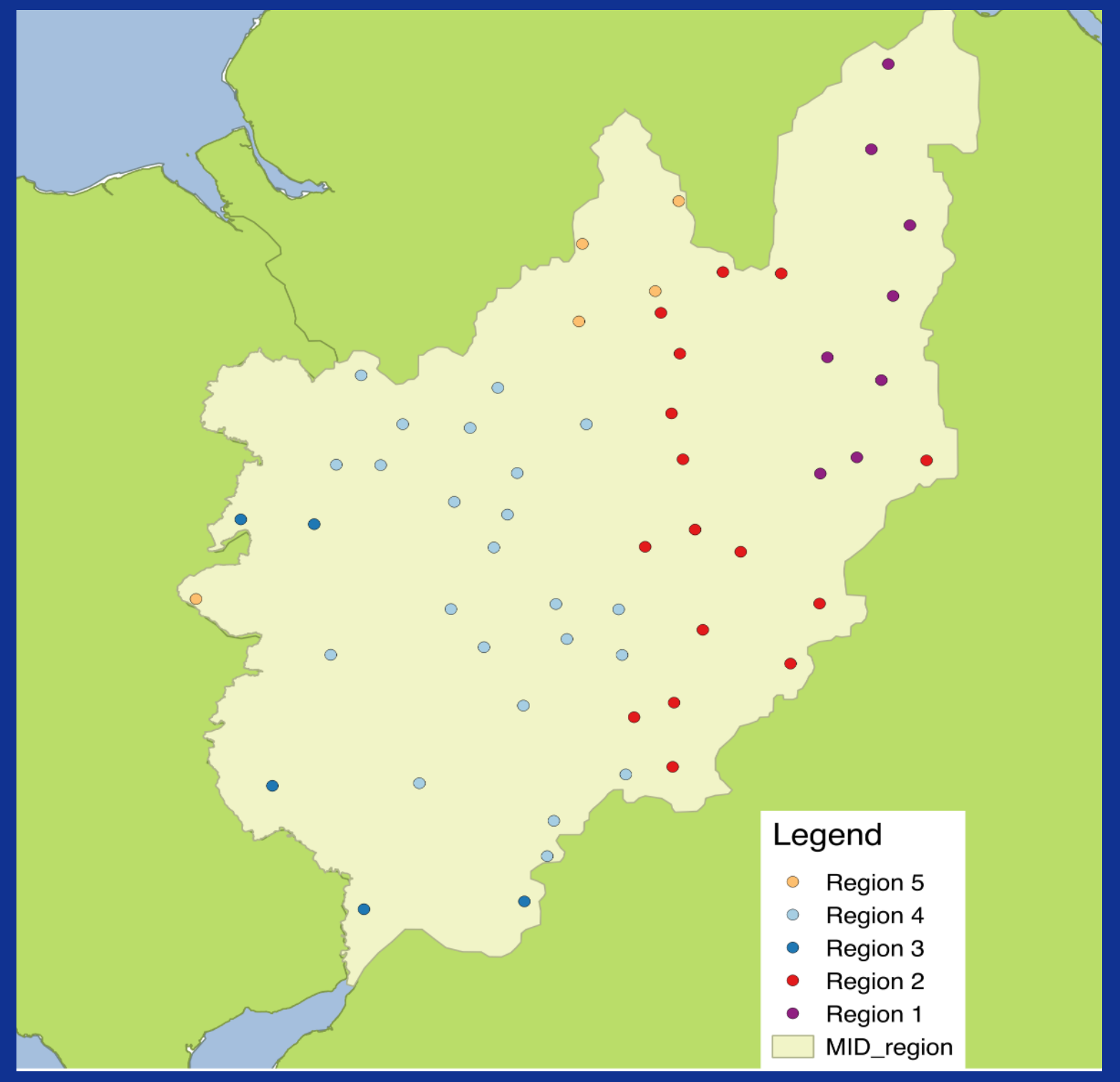
Screening of annual maxima at each site using a discordancy measure based on L-moment ratios

Grouping of sites into homogeneous regions using Ward's Minimum Variance Hierarchical Clustering method

Choosing distribution of best fit for each region, adopted as the Regional Growth Curve

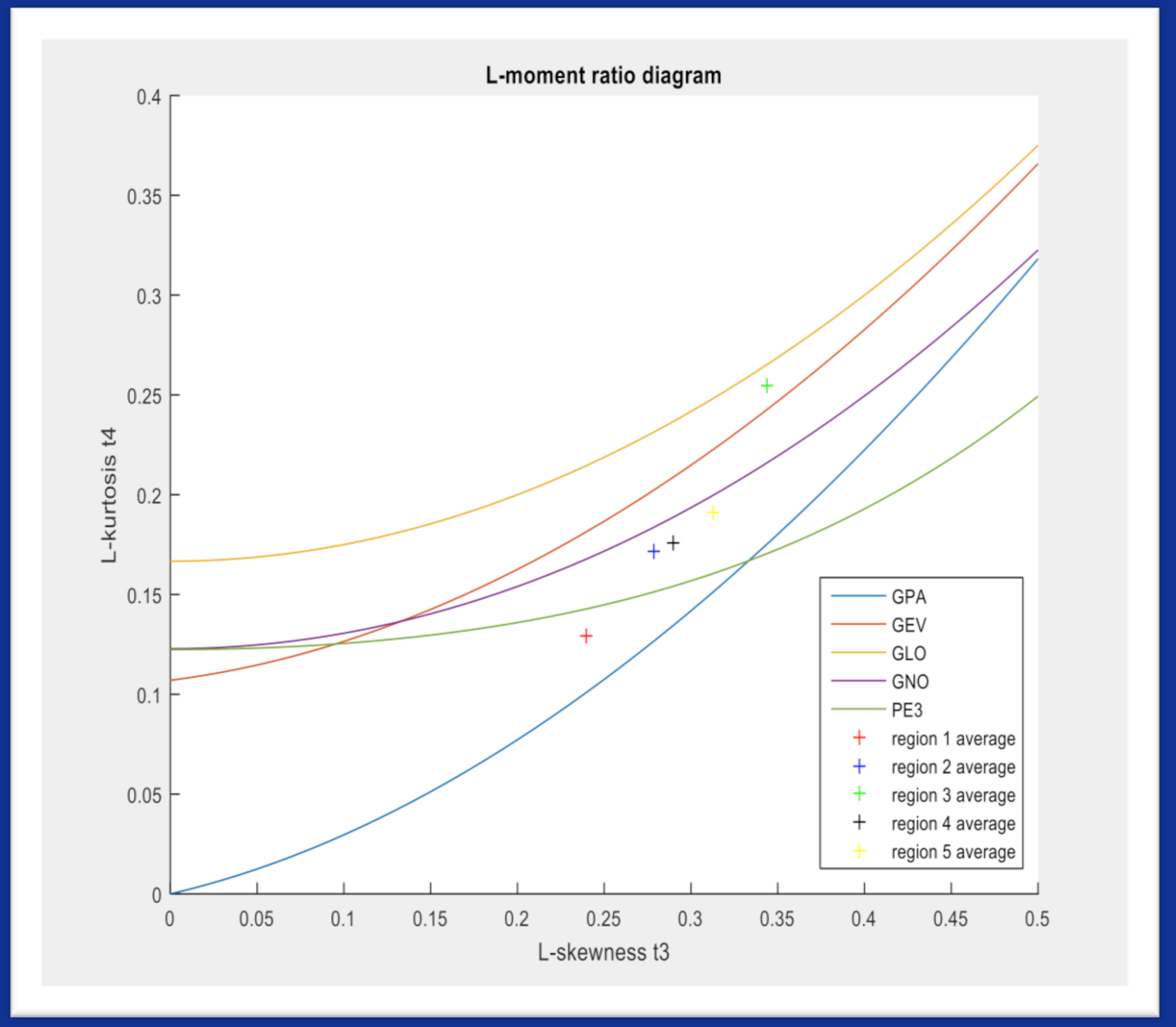
Estimation of quantiles at selected return periods for each site

FORMATION OF REGIONS



DISTRIBUTION FITTING

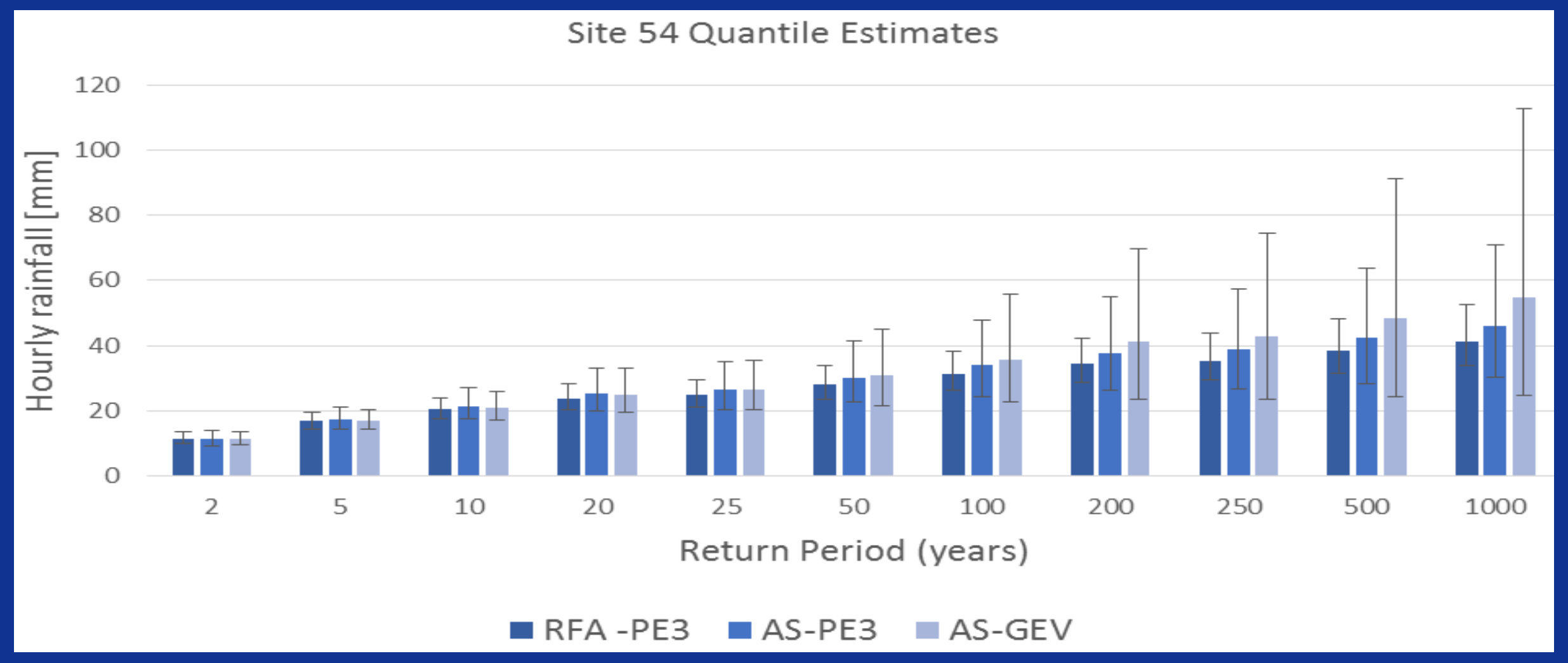
Region	Distribution
1	PE3
2	GNO
3	GLO
4	GNO
5	GNO

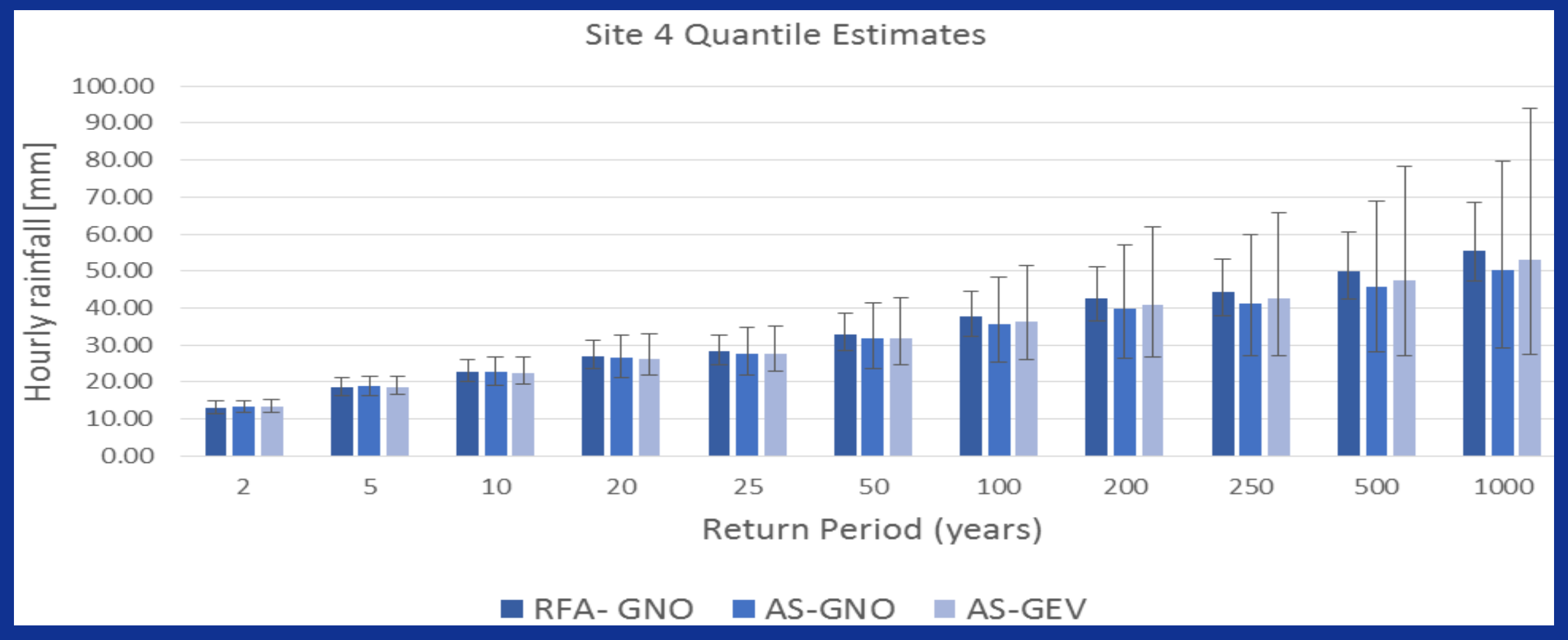


AT-SITE ESTIMATION COMPARISON

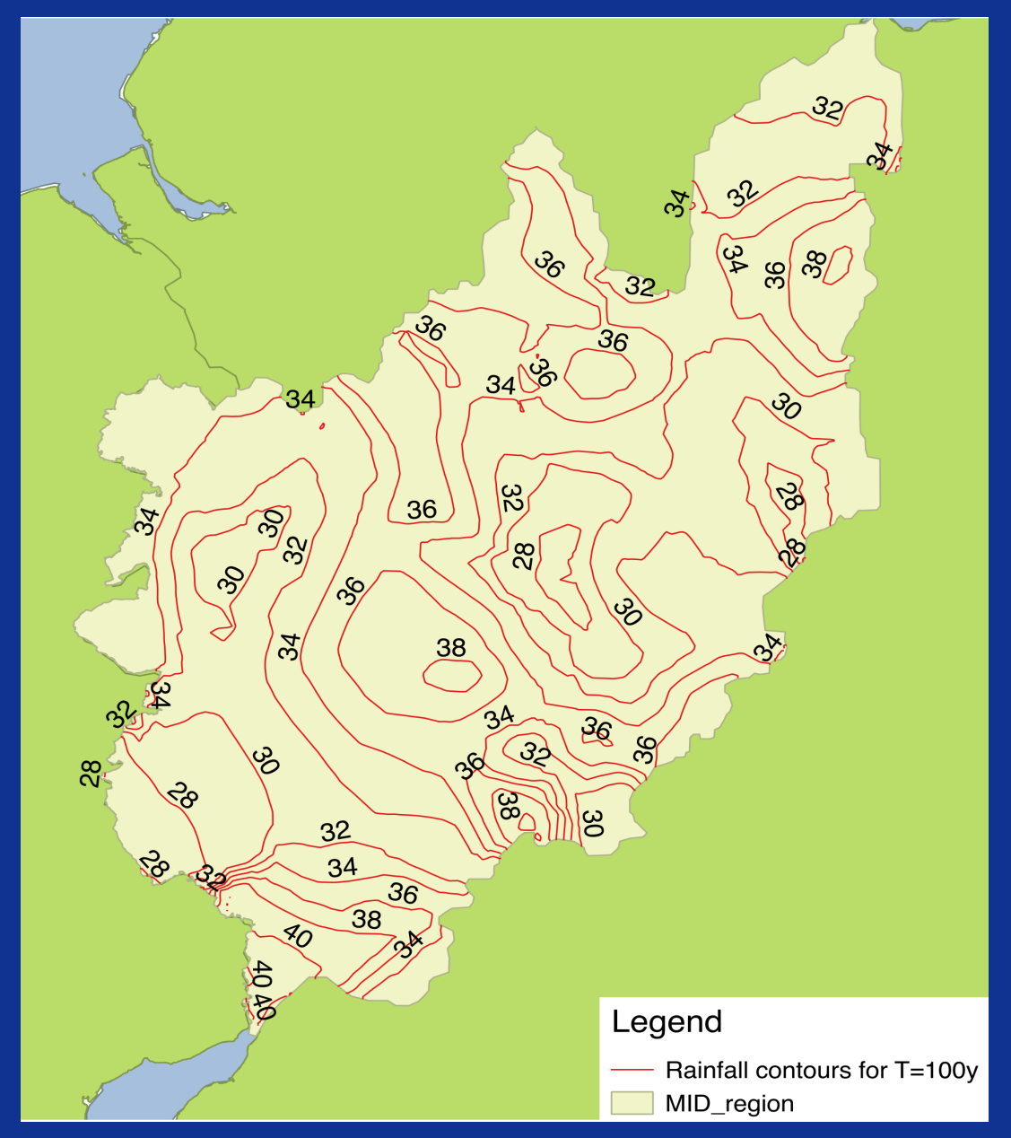
Comparison of the accuracy of quantiles using regional and at-site estimation

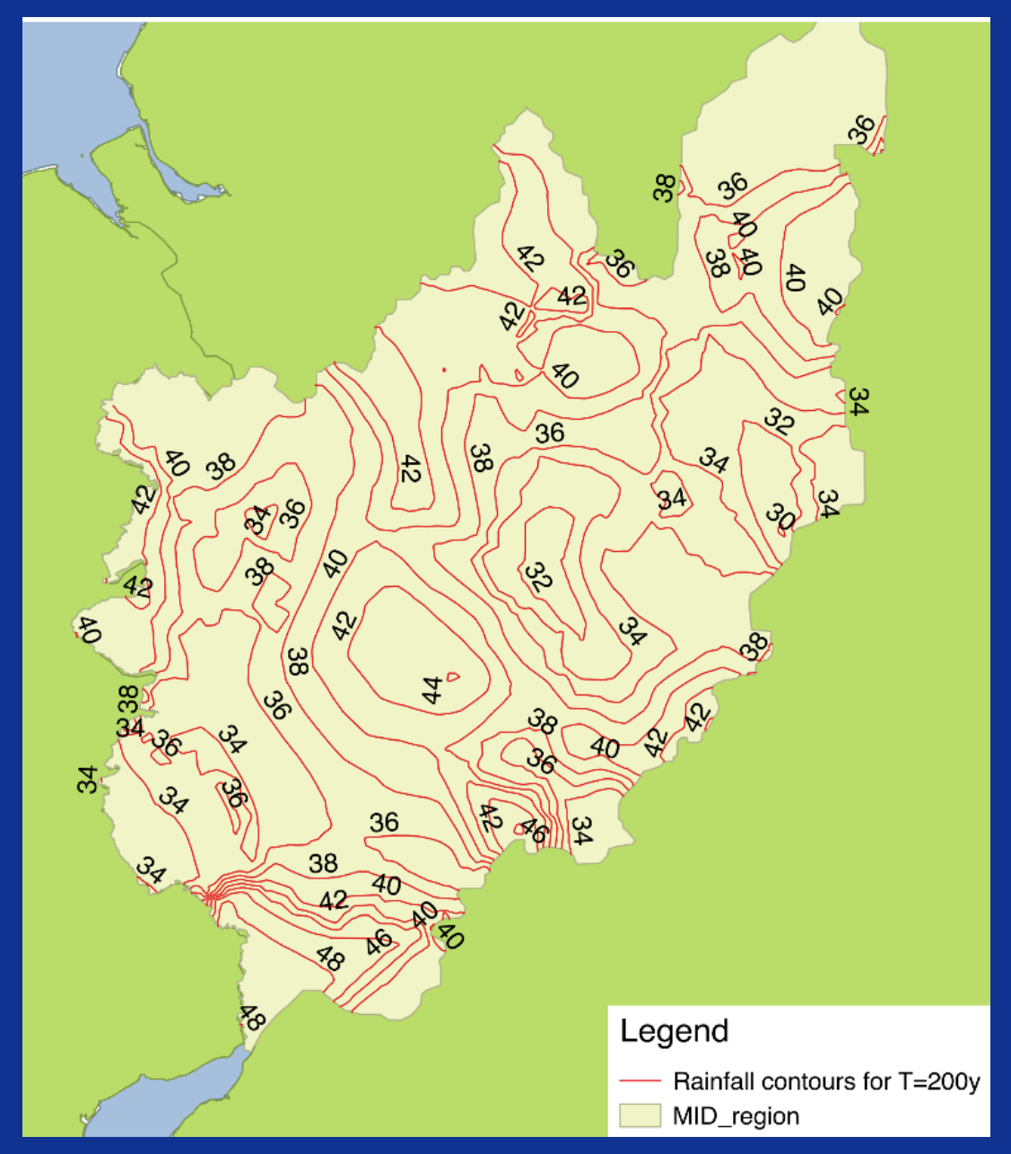
				RMSE (%)		
Region	Site No.	T (years)	F	Regional	At-Site	At-Site GEV
1	54 (PE3)	10	0.9	3.2	4.48	4.11
		50	0.98	4.0	9.92	12.61
		100	0.99	4.6	12.74	20.32
		500	0.998	6.0	19.86	60.95
		1000	0.999	6.7	23.09	98.01
2	4 (GNO)	10	0.9	1.89	2.35	2.17
		50	0.98	3.04	5.58	5.55
		100	0.99	3.67	7.62	8.15
		500	0.998	5.52	14.00	18.52
		1000	0.999	6.51	17.56	25.88
3	19 (GLO)	10	0.9	2.08	2.59	2.54
		50	0.98	5.03	7.40	6.68
		100	0.99	7.34	11.27	9.89
		500	0.998	16.99	28.53	22.93
		1000	0.999	24.06	42.11	32.24
4	1 (GNO)	10	0.9	1.97	1.86	1.89
		50	0.98	3.16	3.54	3.62
		100	0.99	3.82	4.52	4.72
		500	0.998	5.76	7.31	8.07
		1000	0.999	6.80	8.73	9.89
5	13 (GNO)	10	0.9	2.14	3.34	3.03
		50	0.98	4.08	10.23	10.44
		100	0.99	5.29	15.73	17.56
		500	0.998	9.14	39.04	56.44
		1000	0.999	11.29	56.15	92.55

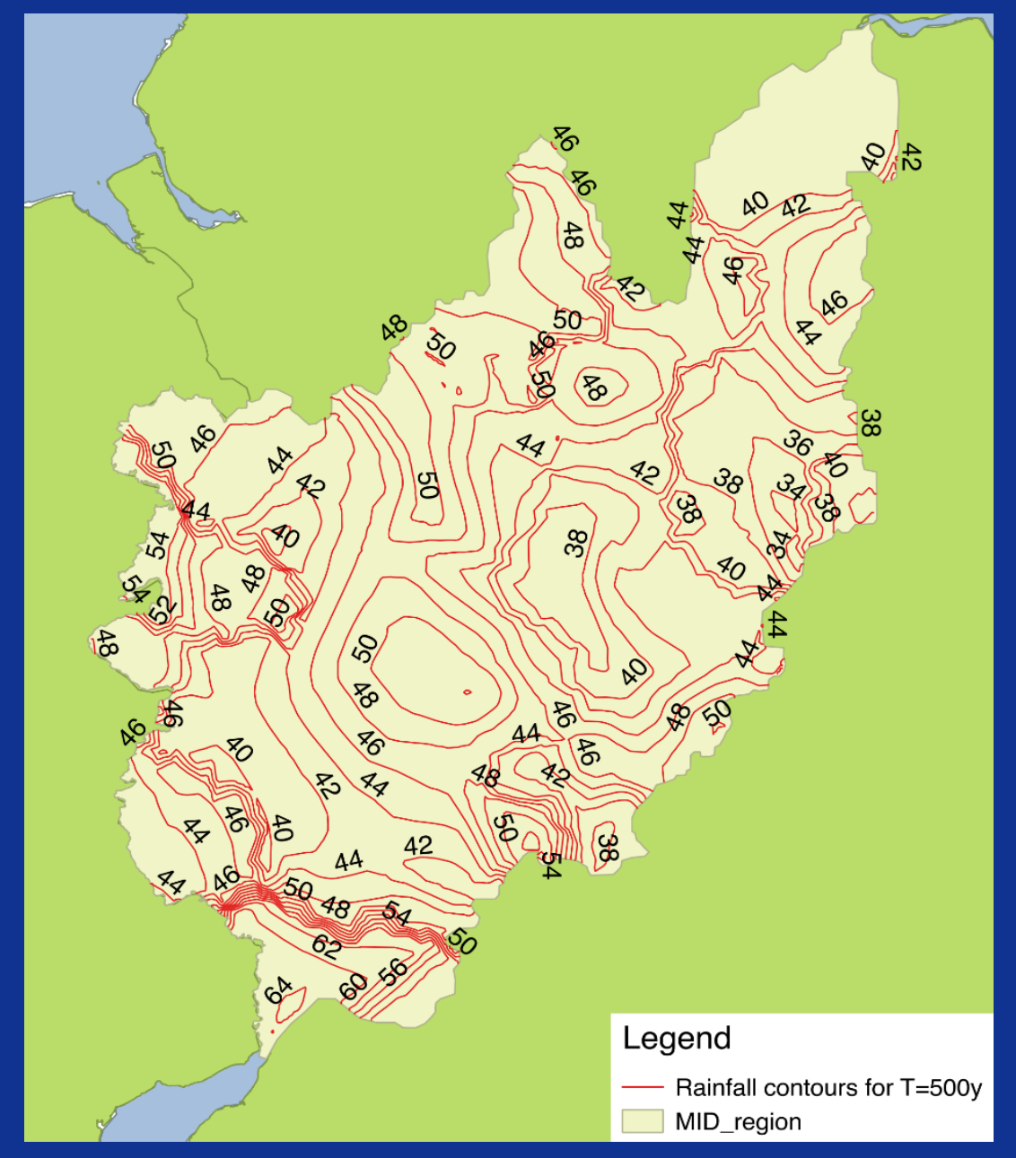


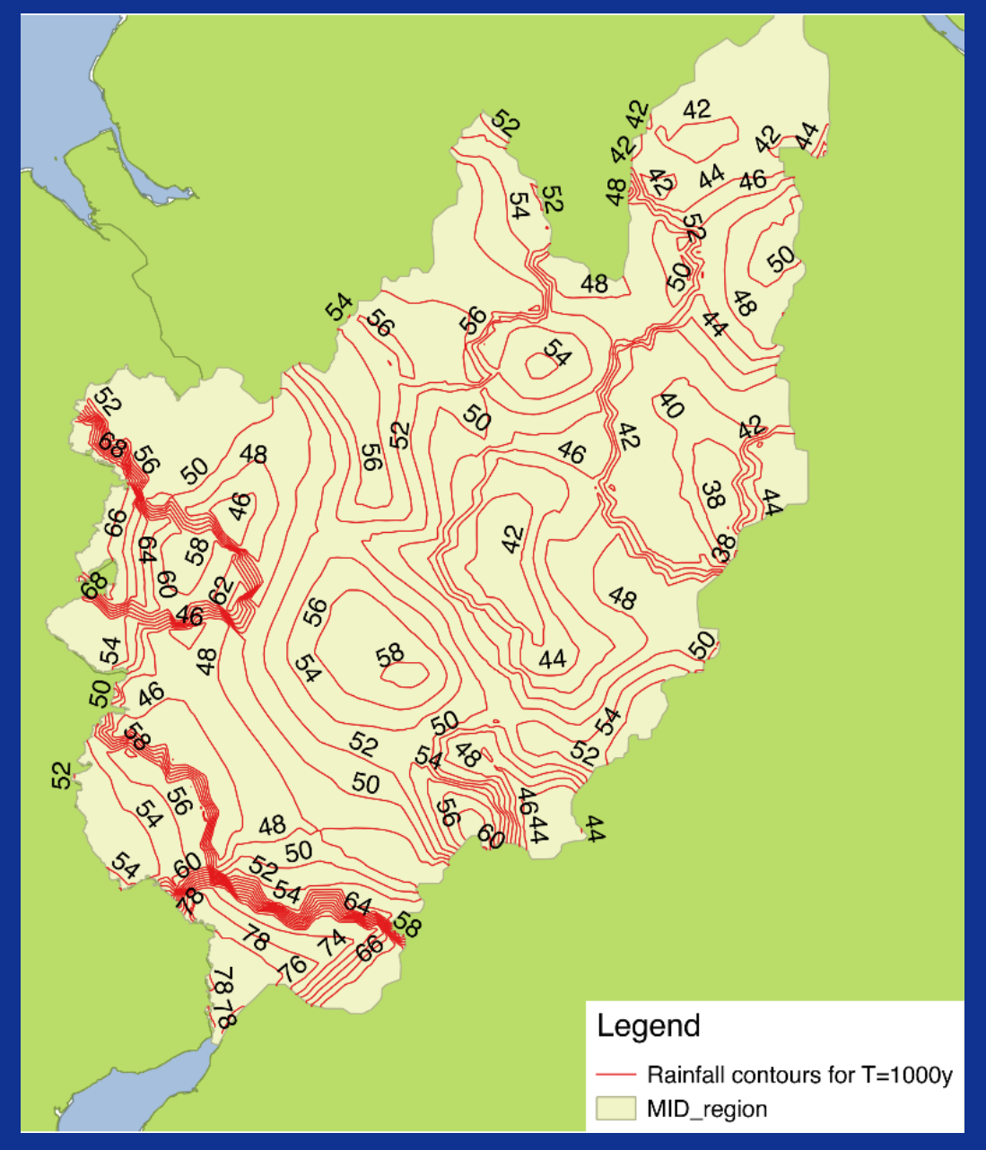


RAINFALL EXTREMES AT UNGAUGED LOCATIONS









CONCLUSIONS

Accuracy and reliability assessments using Monte Carlo simulation proved that quantile estimates have RMSEs and error bounds that are relatively low, especially for regions 1, 2 and 4. Results were not as positive for regions 3 and 5, mainly because of the small number of sites they are comprised of. Furthermore, the accuracy and reliability of estimates is lower at higher return periods. A comparison with the traditional method of at-site estimation proved that estimates using Regional Frequency Analysis are significantly more accurate and reliable for return periods greater than 100 years, even for the smaller sized regions. An interesting finding was that at-site estimation using the underlying distribution identified for each region proved to be more accurate and reliable than the fitting of the Generalized Extreme Value Distribution, which is the traditional distribution used to model annual maxima. No evidence on whether regional estimates overestimate or underestimate extremes has been found.

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