Using structured expert judgment to Estimate extreme river discharges: a case study of the Meuse River - Supplementary material

Guus Rongen

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Contents

1 Introduction

This documents serves as a supplement to the article ”Using structured expert judgment to Estimate extreme river discharges: a case study of the Meuse River” by Guus Rongen, Oswaldo Morales-Nápoles, and Matthijs Kok. The article describes a method to estimate extreme discharges with expert judgment, in a case study for the river Meuse. The information in this supplement presents more detailed results for the expert elicitation. Section 2 shows each expert’s estimates, for all the items. Section 3 shows the generalized extreme value (GEV) distributions that were fitted to these estimates using Markov chain Monte Carlo: Section 3.1 for the tributaries, which were directly fitted to the annual maxima observations and expert estimated (Sect. 2), and Sect. 3.2 for the discharges at the downstream locations, which are a combination of the upstream tributaries, the correlations, and the fitted sum-factors. Finally, Sect. 4 contains background information on the hydrology of the Meuse catchment that was available to the experts during the elicitation.

2 Expert estimates

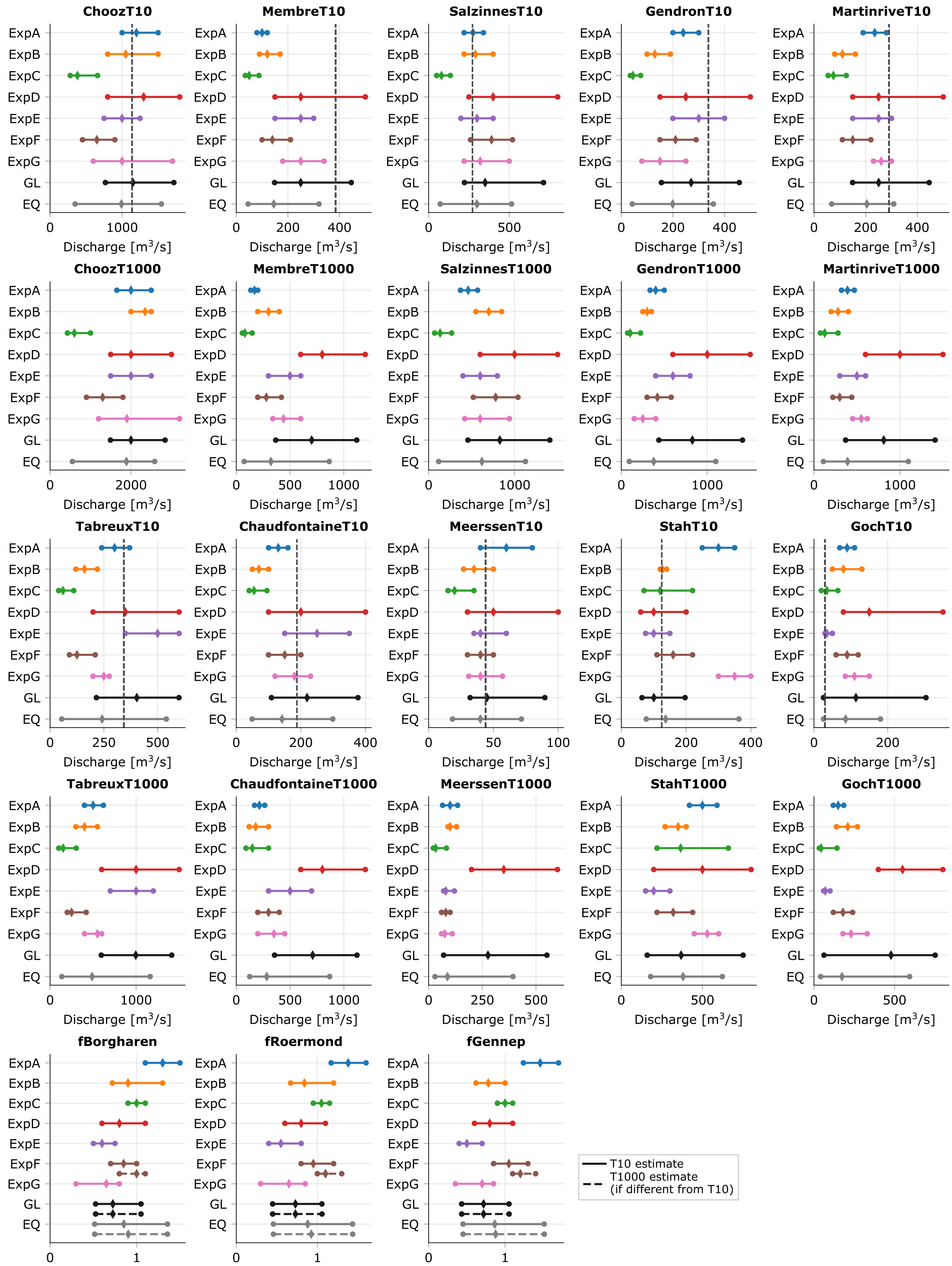

Figure 2.1 Overview of expert estimates for all items.

3 Fitted exceedance frequency curves

This chapter shows the fitted distributions for the tributary discharges (see Section 3.1) and downstream discharges, and the factors that where . The tirbutary discharges are fitted to observations (see Figure 3.1), expert estimates, and data (see Figure 3.3 to Figure 3.14)

3.1 Exceedance frequency curves for tributaries

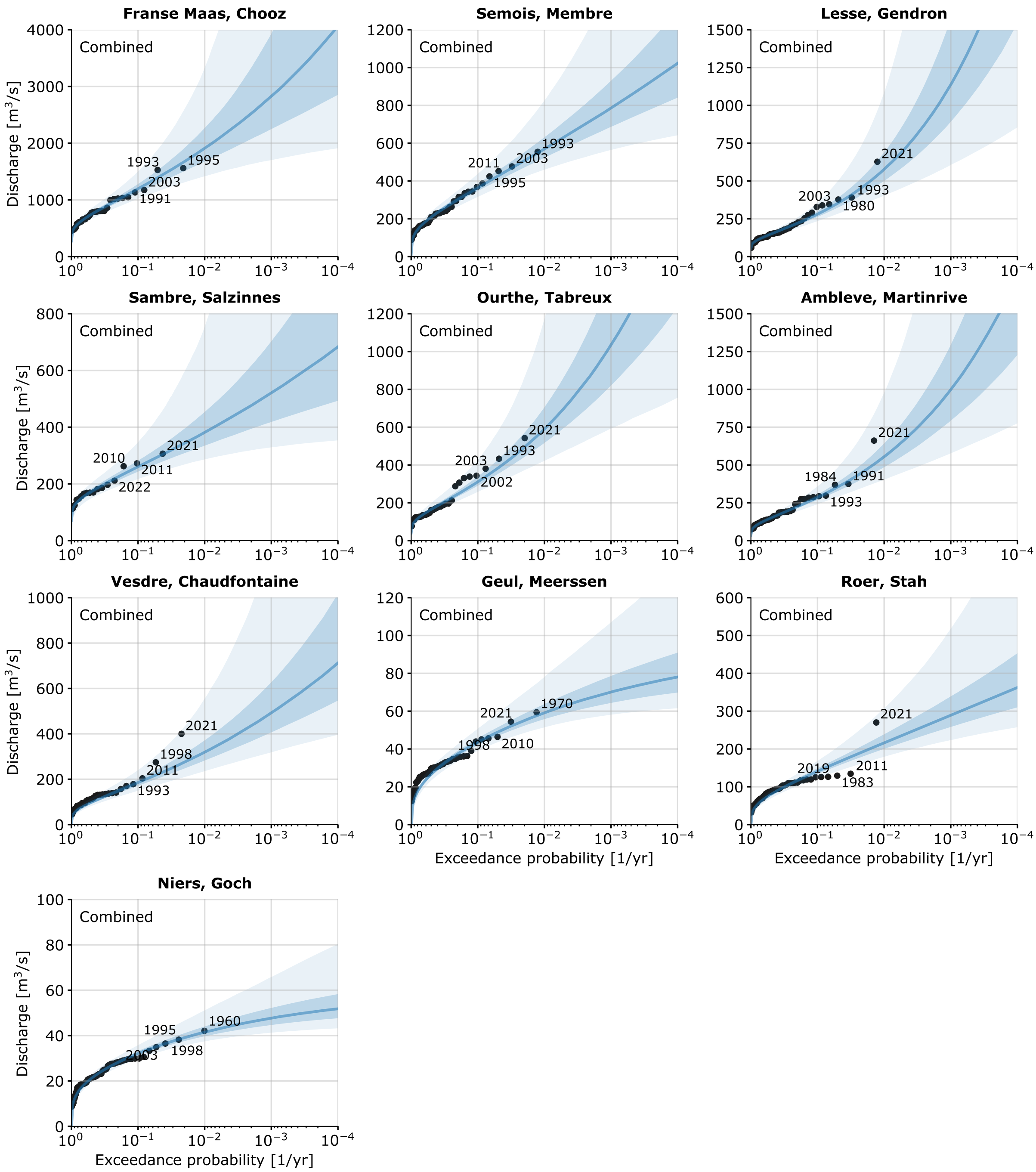

Figure 3.1 Exceedance frequency curves of tributary discharges fitted only to observed annual maxima.

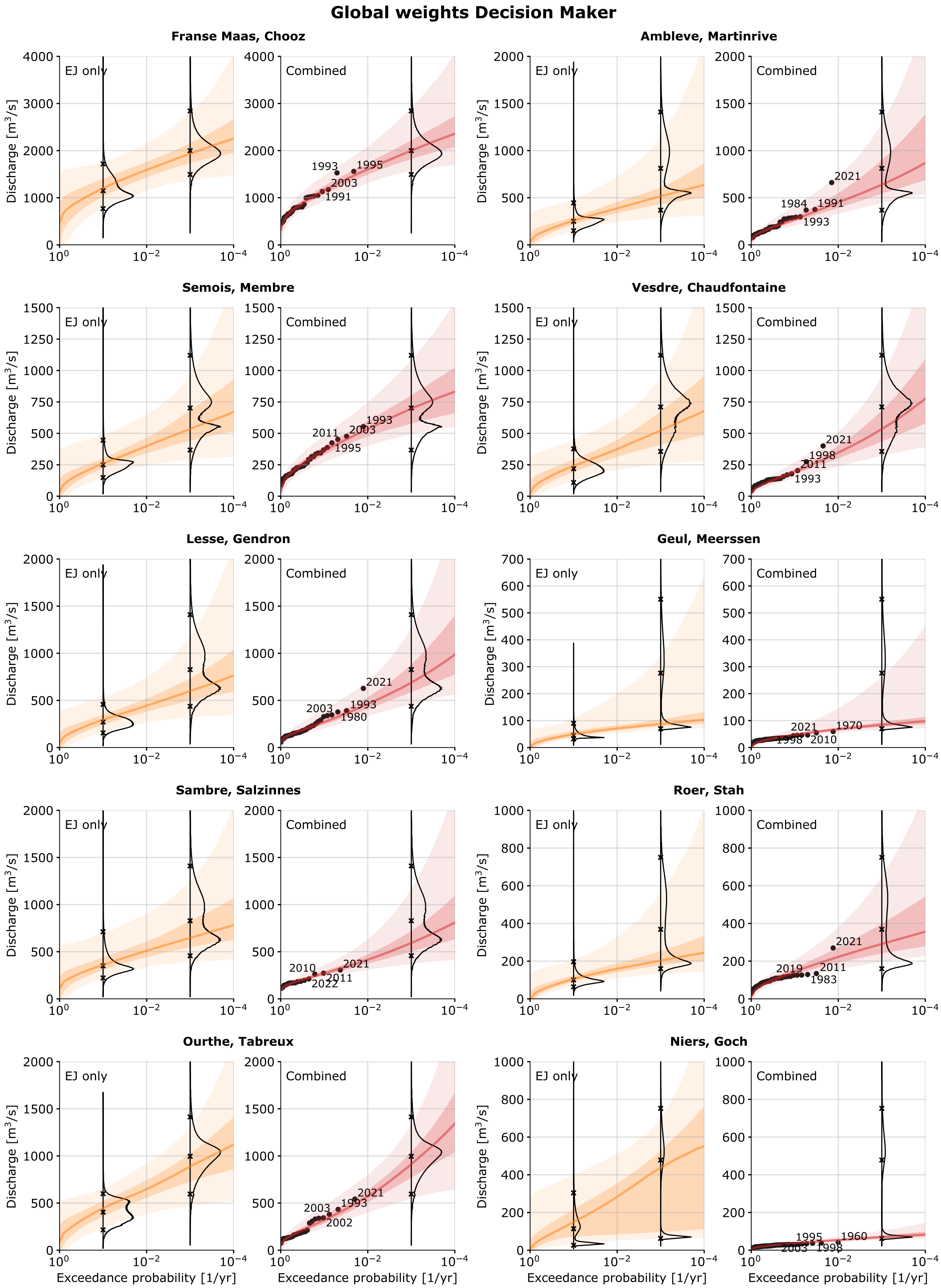

Figure 3.2 Exceedance frequency curves of tributary discharges for the global weights decision maker. Fitted to only the estimates (first and third column), and the combination between estimates and data (second and fourth column).

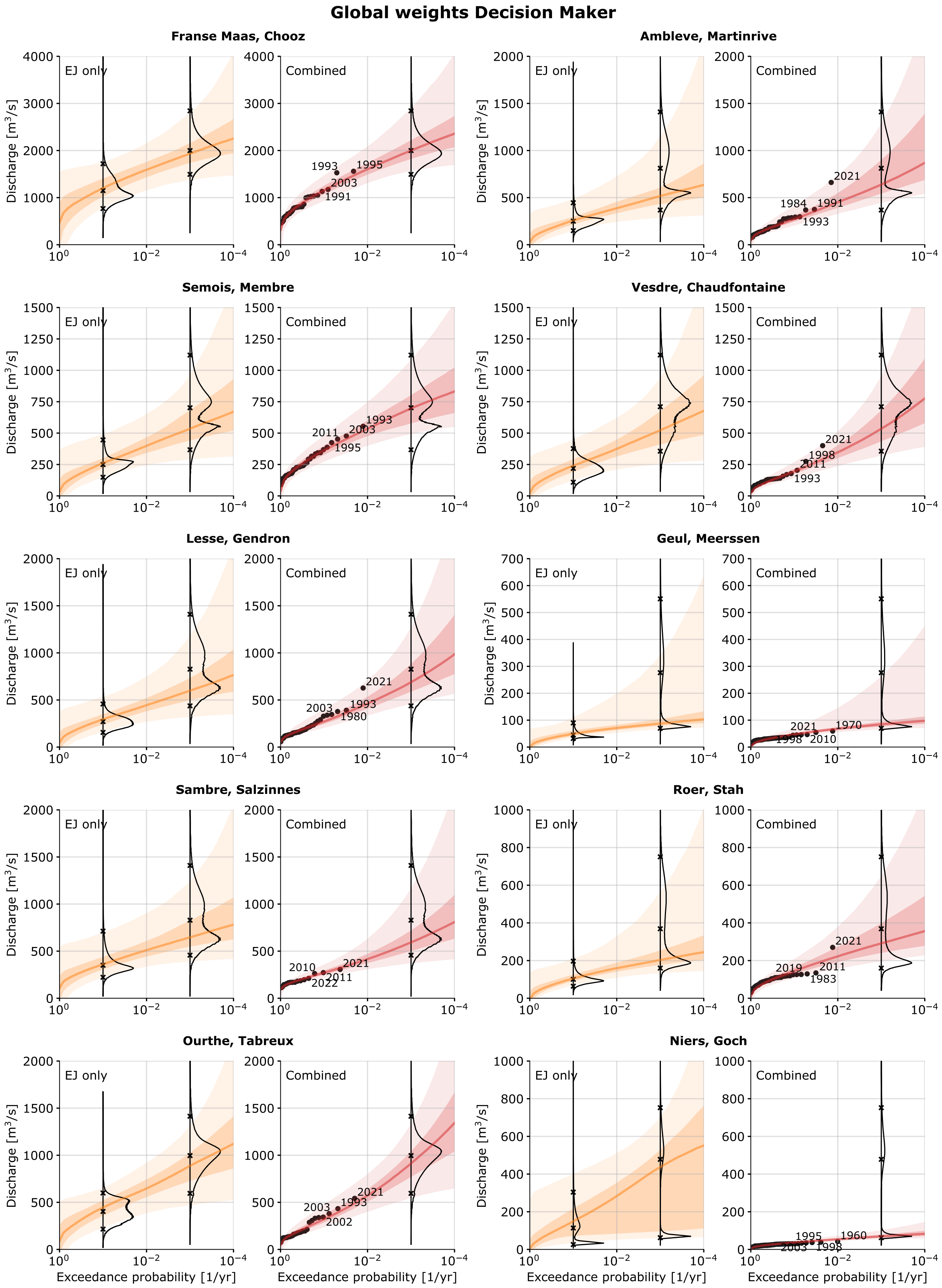

Figure 3.3 Exceedance frequency curves of tributary discharges for the global weights decision maker. Fitted to only the estimates (first and third column), and the combination between estimates and data (second and fourth column).

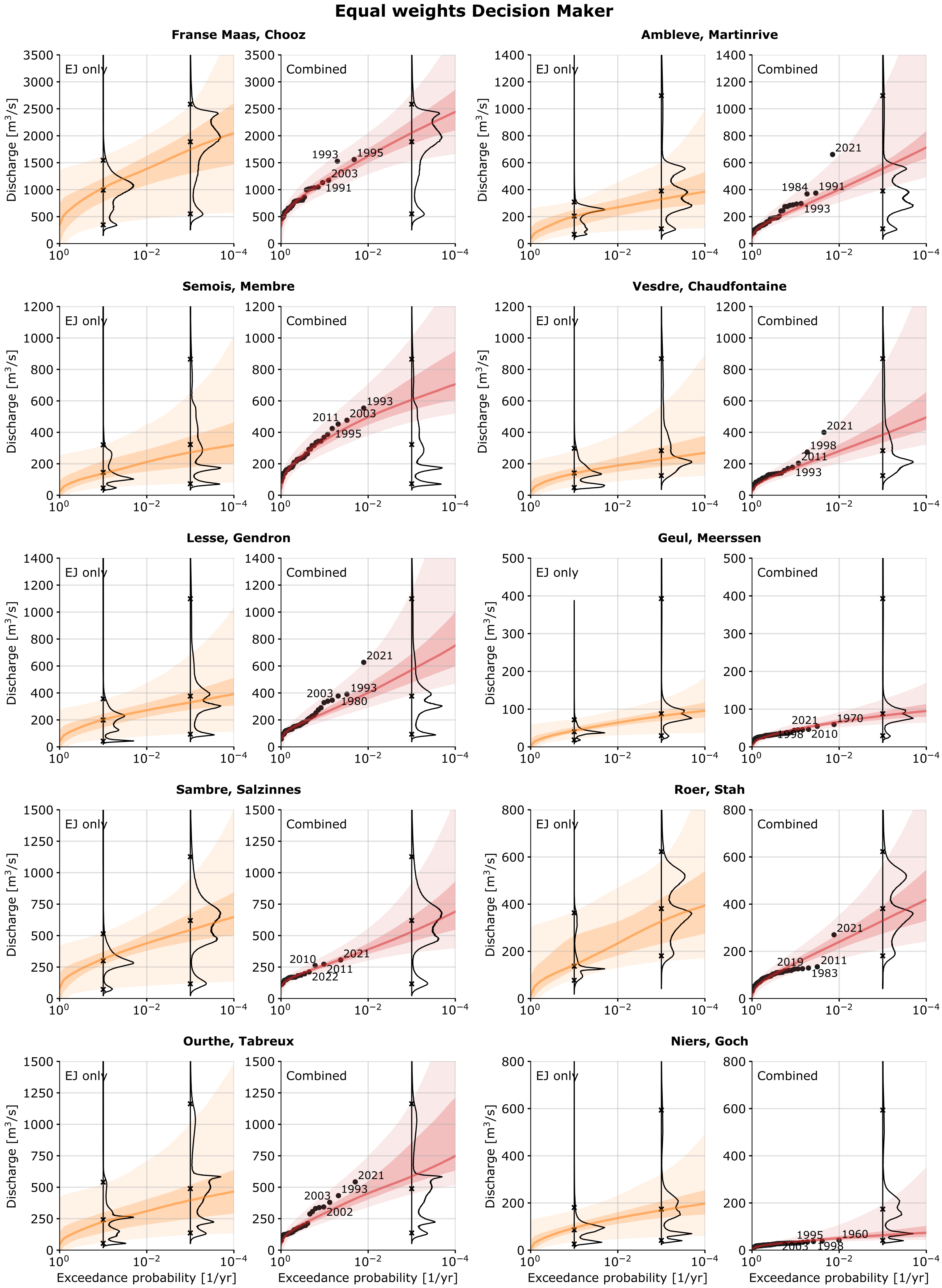

Figure 3.4 Exceedance frequency curves of tributary discharges for the equal weights decision maker. Fitted to only the estimates (first and third column), and the combination between estimates and data (second and fourth column).

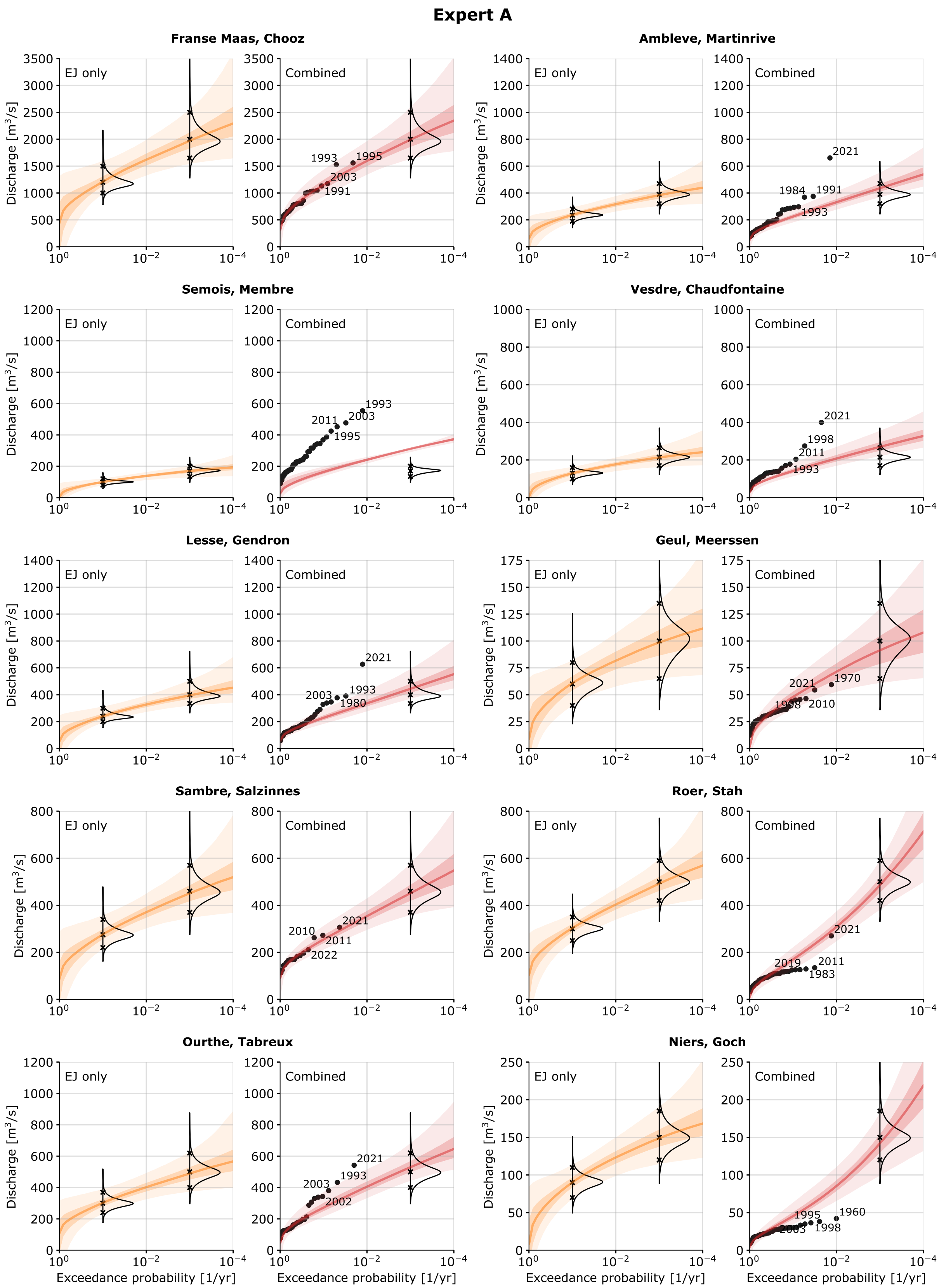

Figure 3.5 Exceedance frequency curves of tributary discharges for Expert A. Fitted to only the estimates (first and third column), and the combination between estimates and data (second and fourth column).

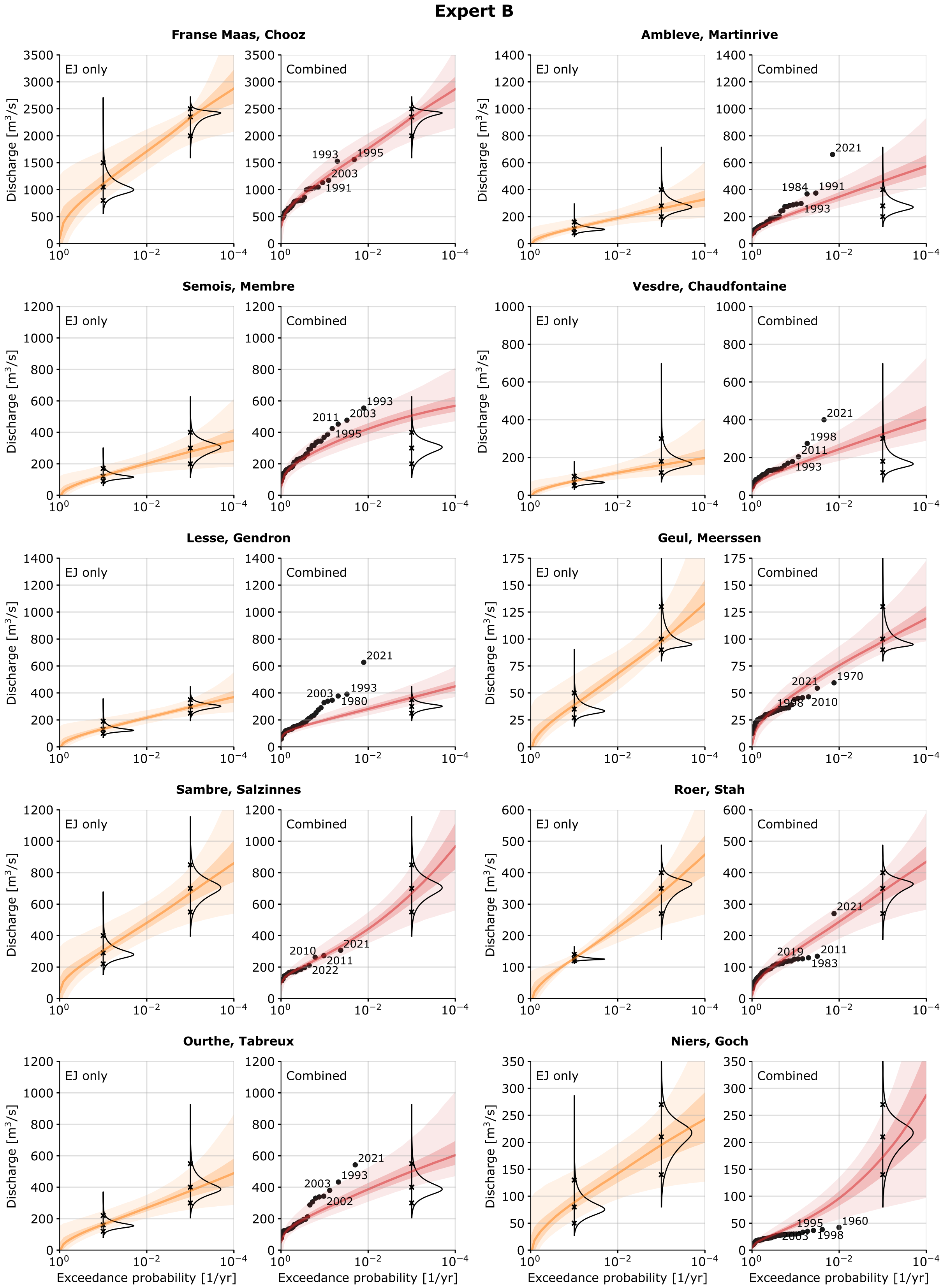

Figure 3.6 Exceedance frequency curves of tributary discharges for Expert B. Fitted to only the estimates (first and third column), and the combination between estimates and data (second and fourth column).

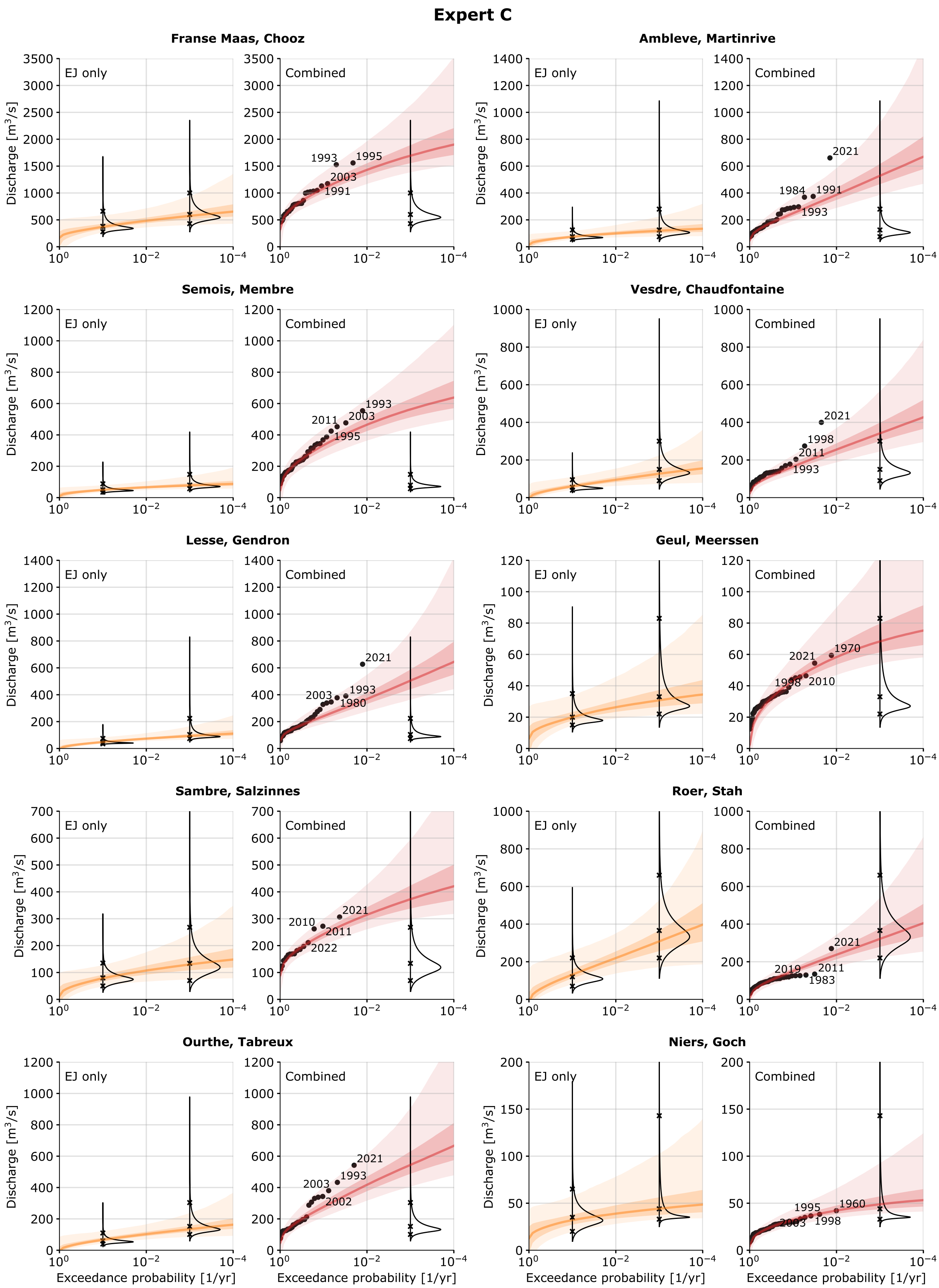

Figure 3.7 Exceedance frequency curves of tributary discharges for Expert C. Fitted to only the estimates (first and third column), and the combination between estimates and data (second and fourth column).

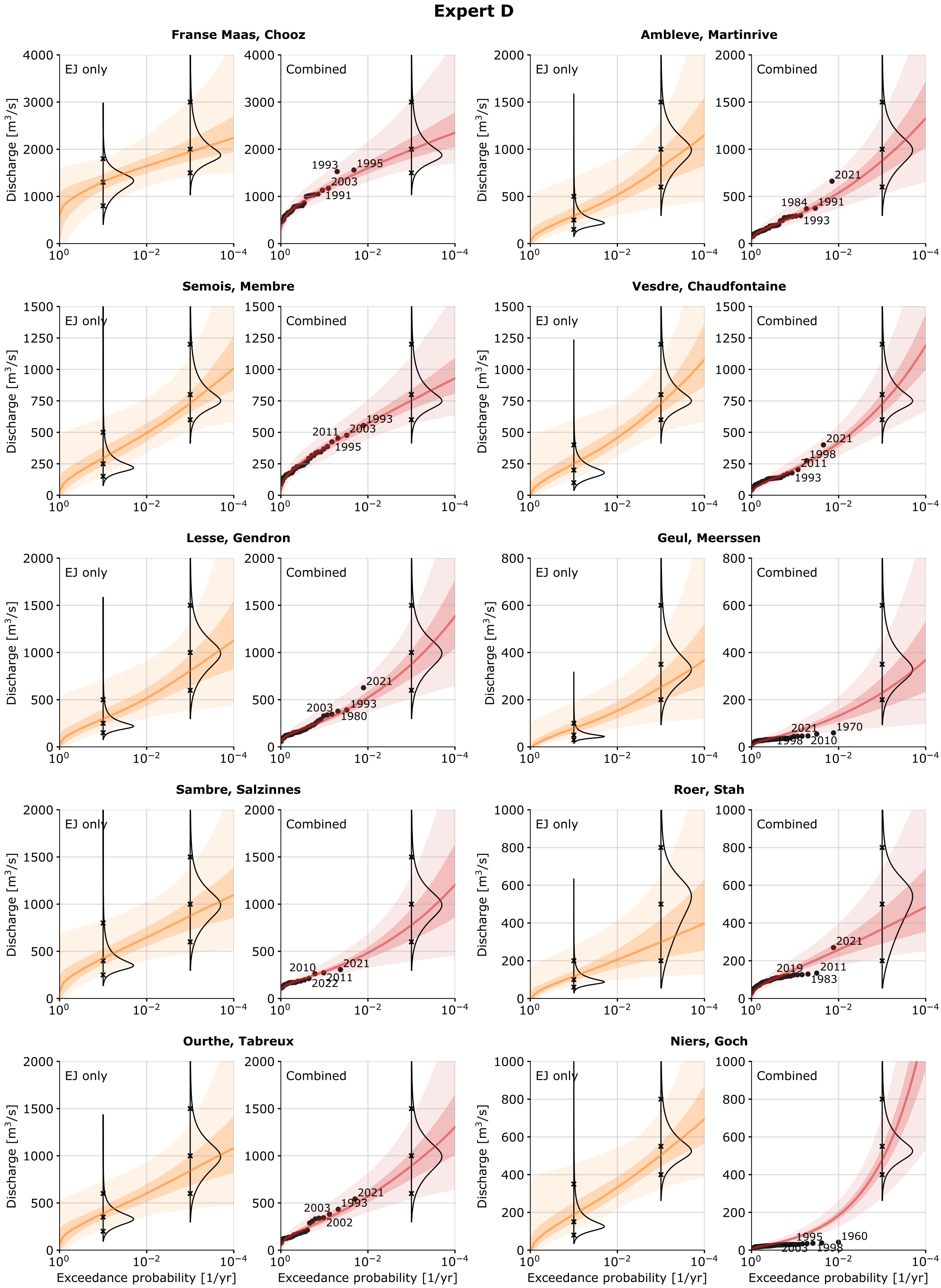

Figure 3.8 Exceedance frequency curves of tributary discharges for Expert D. Fitted to only the estimates (first and third column), and the combination between estimates and data (second and fourth column).

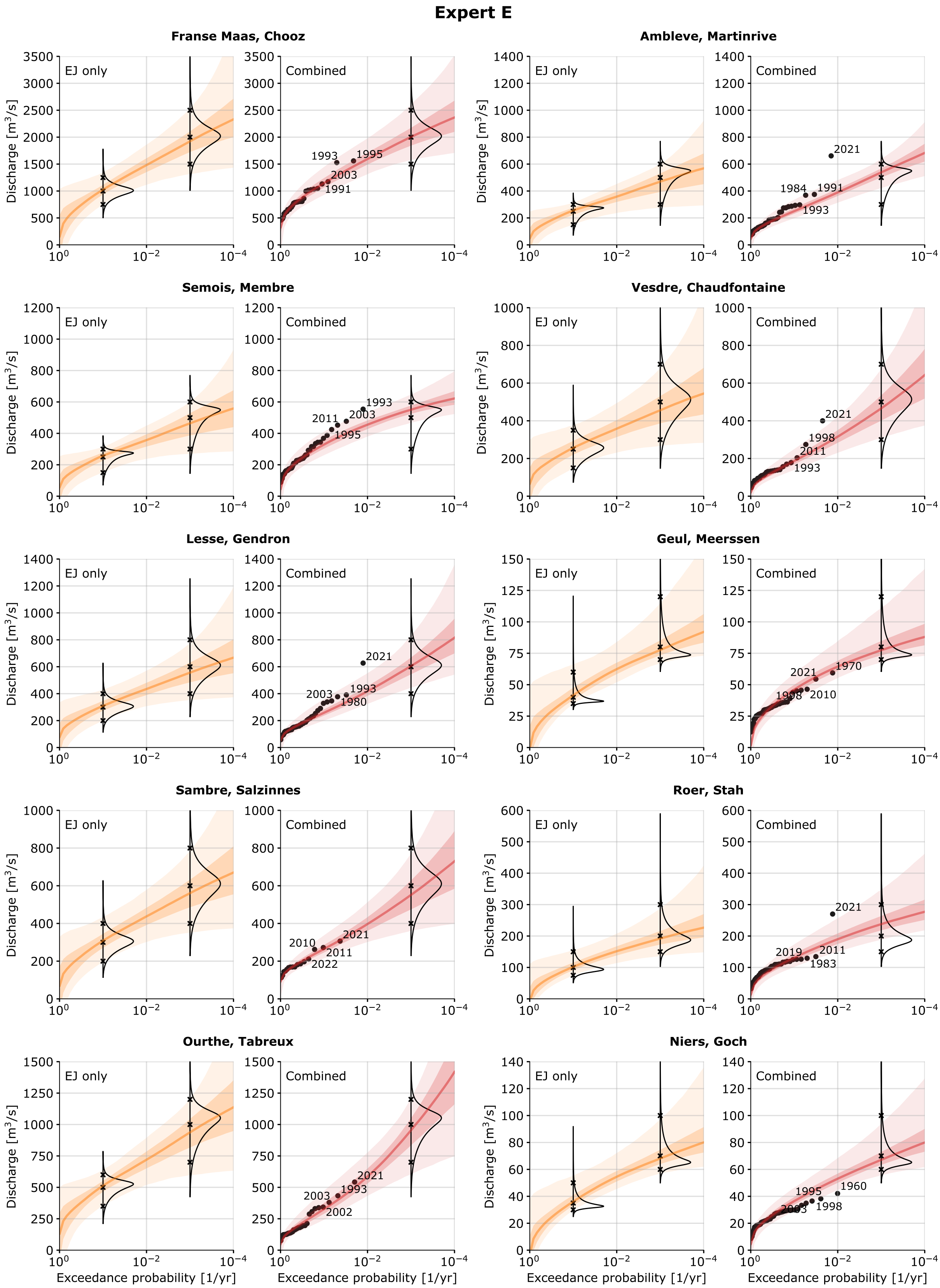

Figure 3.9 Exceedance frequency curves of tributary discharges for Expert E. Fitted to only the estimates (first and third column), and the combination between estimates and data (second and fourth column).

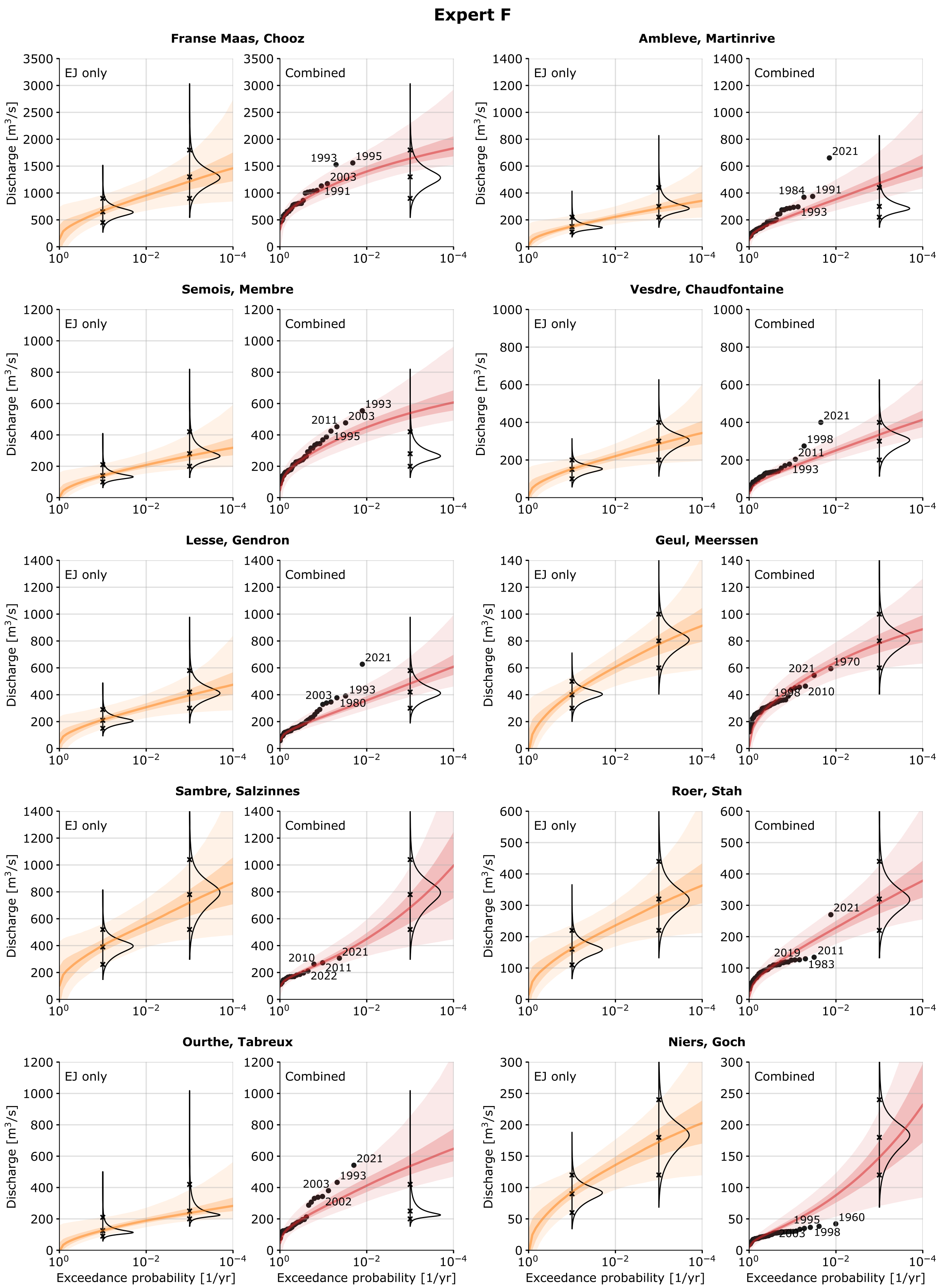

Figure 3.10 Exceedance frequency curves of tributary discharges for Expert F. Fitted to only the estimates (first and third column), and the combination between estimates and data (second and fourth column).

Expert G

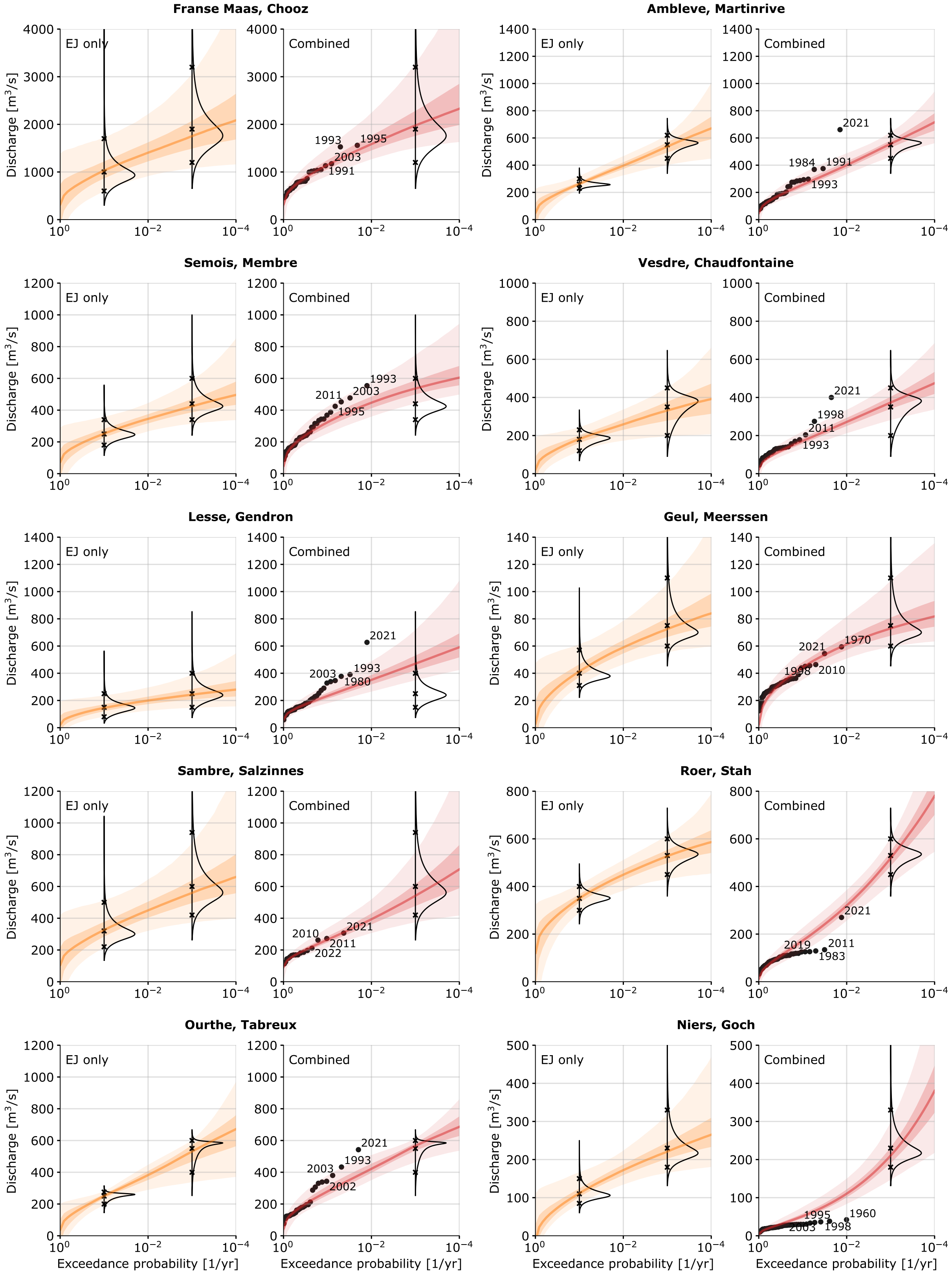

Figure 3.11 Exceedance frequency curves of tributary discharges for Expert G. Fitted to only the estimates (first and third column), and the combination between estimates and data (second and fourth column).

3.2 Exceedance frequency curves for downstream discharges

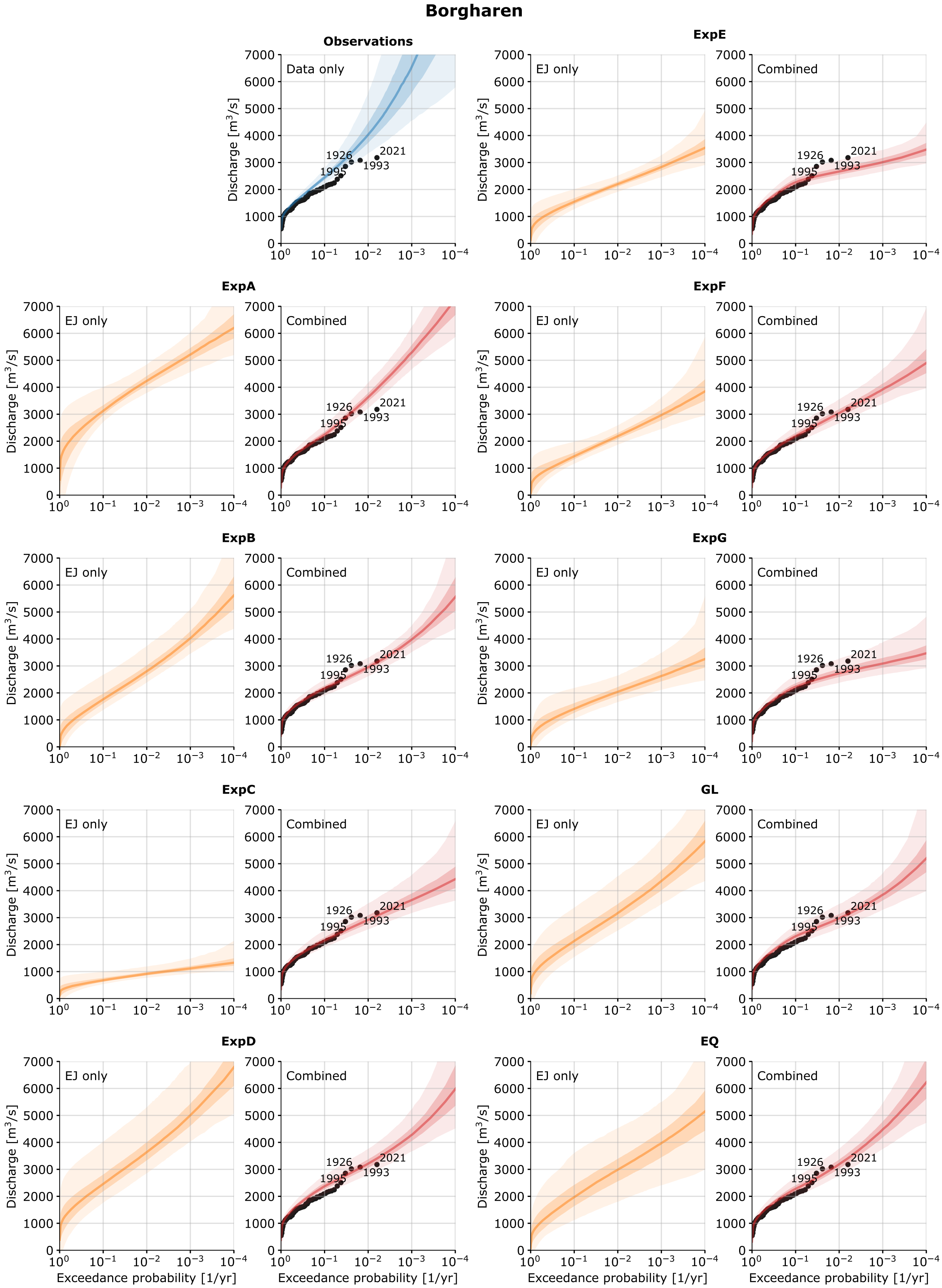

Figure 3.12 Exceedance frequency curves of the downstream discharges at Borgharen. Fitted to observations (blue), only estimates (orange), and the combination between estimates and data (red).

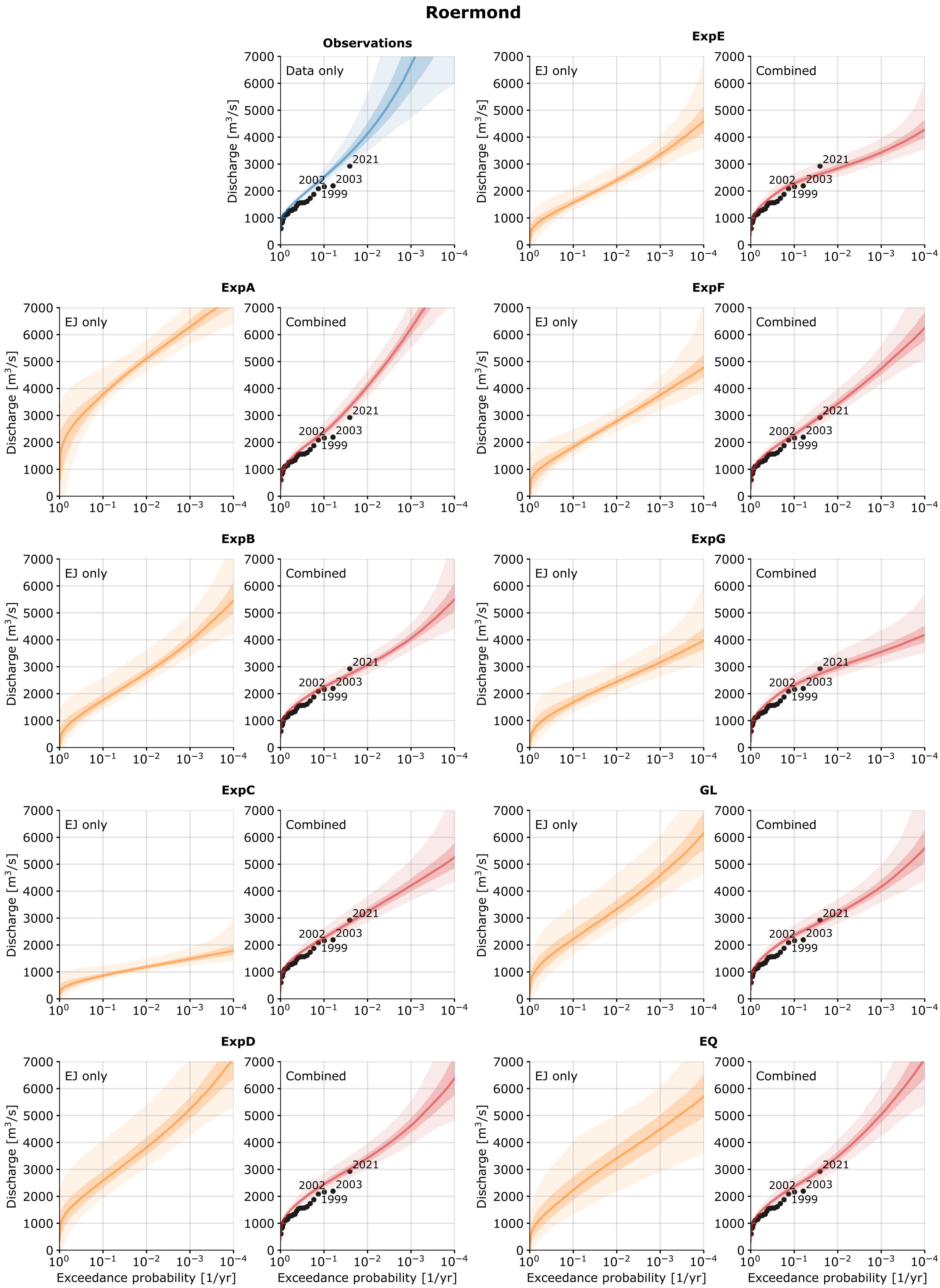

Figure 3.13 Exceedance frequency curves of the downstream discharges at Roermond. Fitted to observations (blue), only estimates (orange), and the combination between estimates and data (red).

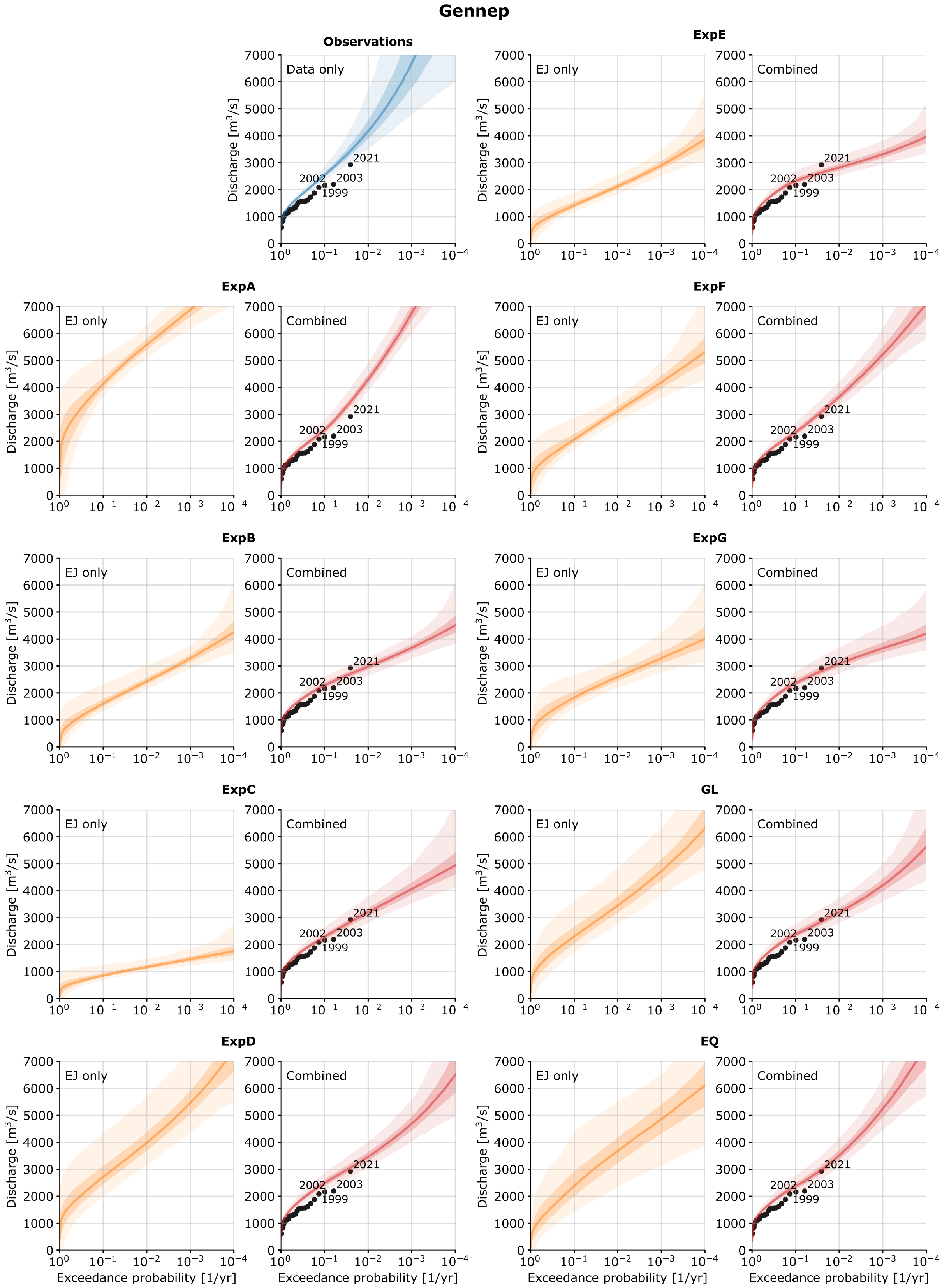

Figure 3.14 Exceedance frequency curves of the downstream discharges at Gennep. Fitted to observations (blue), only estimates (orange), and the combination between estimates and data (red).

4 Hydrological information on the river Meuse

4.1 Catchment overview

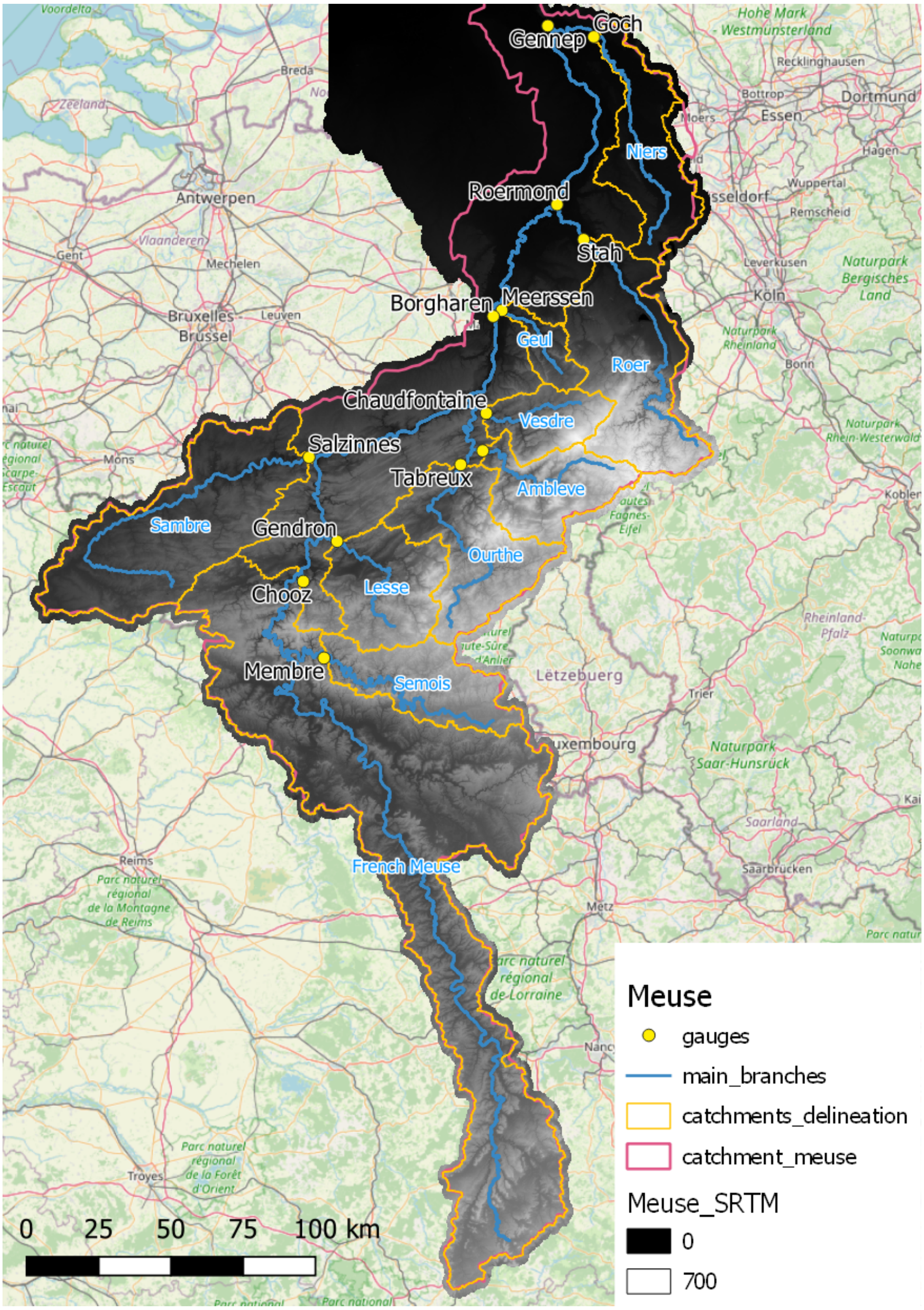

Figure 4.1 Digital elevation map of the Meuse catchment. Background map tiles: © OpenStreetMap contributors

4.2 Land use

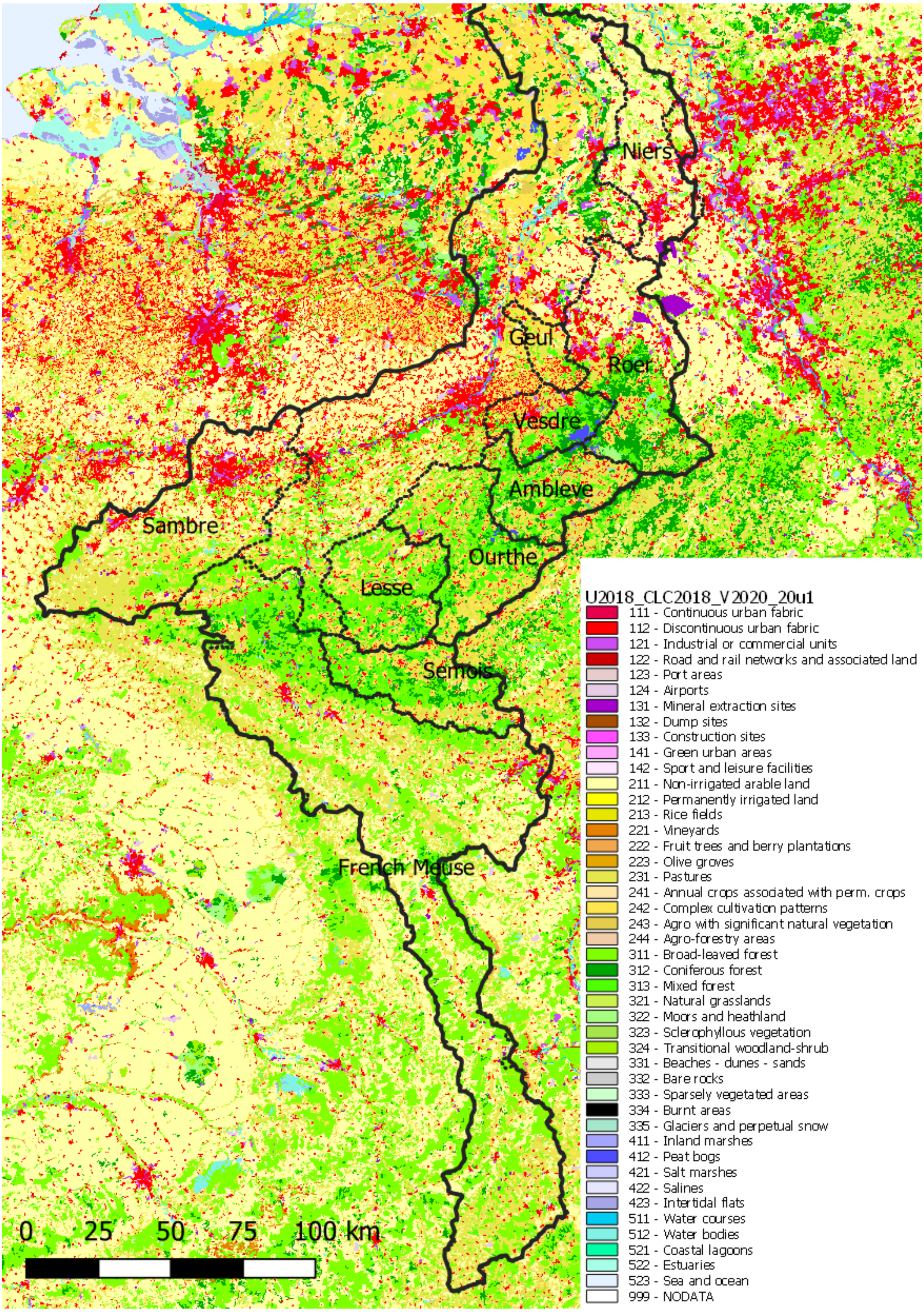

Figure 4.2 Land use in the Meuse catchment

4.3 River profiles and time of concentration

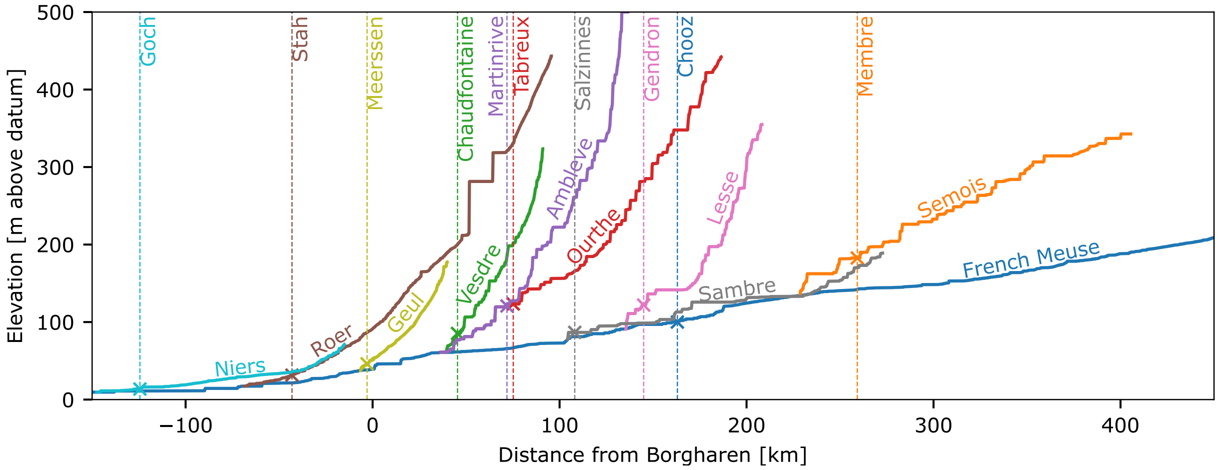

Figure 4.3 Vertical profile of the considered tributaries.

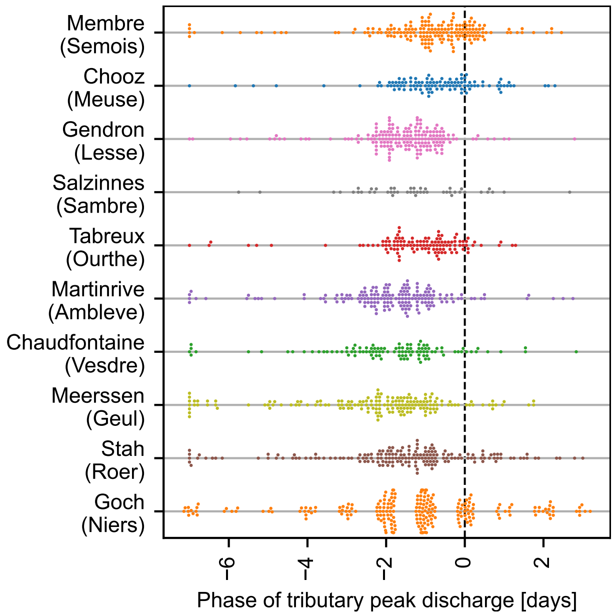

Figure 4.4 Time difference between peak discharge on tributary and the peak discharge at Borgharen.

4.4 Characteristics of subcatchments

4.4.1 Area

Note that the confluence of the Semois is upstream of Chooz. The percentages of Semois in the table below are included in the percentages and area for Chooz. You don't have to take this into account for your estimates, just make them for Chooz or Membre, considering all of the upstream area.

Table 4.1 Areas in the Meuse catchment

station	river	area	percent Borgharen	percent Roermond	percent Gennep
Chaudfontaine	Vesdre	688.6	3.2	2.7	2.4
Chooz	French Meuse	10161.6	47.7	40.6	36.1
Gendron	Lesse	1281.1	6.0	5.1	4.5
Martinrive	Ambleve	1065.9	5.0	4.3	3.8
Salzinnes	Sambre	2875.4	13.5	11.5	10.2
Tabreux	Ourthe	1609.1	7.5	6.4	5.7
Membre	Semois	1225.7	5.7	4.9	4.4
Stah	Roer	2096.7		8.4	7.4
Meerssen	Geul	338.7		1.4	1.2
Goch	Niers	1265.6			4.5
Sum		**21382.7**	**82.9**	**80.3**	**75.9**
Borgharen remainder	Meuse	3641.0	17.1		
Roermond remainder	Meuse	4940.3		19.7	
Gennep remainder	Meuse	6788.1			24.1
Borgharen	Meuse	21322.7			
Roermond	Meuse	25057.4			
Gennep	Meuse	28170.8			

4.4.2 Soil composition

Table 4.2 Soil composition percentages in the Meuse catchment

		topsoil			subsoil		
station	river	sand	silt	clay	sand	silt	clay
Chaudfontaine	Vesdre	41	24	35	40	26	33
Chooz	French Meuse	46	26	28	41	21	26
Gendron	Lesse	39	25	35	38	27	33
Martinrive	Ambleve	38	25	36	38	28	34
Salzinnes	Sambre	50	21	26	44	21	26
Tabreux	Ourthe	39	26	35	37	28	32
Membre	Semois	50	21	30	48	22	29
Stah	Roer	50	22	27	47	22	26
Meerssen	Geul	53	21	26	48	20	26
Goch	Niers	63	19	18	59	15	21

4.4.3 Land use

Table 4.3 Land use percentage in the Meuse catchment

station	river	paved	agriculture	forest & grassland	marshes	waterbodies
Chaudfontaine	Vesdre	18.9	31.0	44.7	5.0	0.4
Chooz	French Meuse	5.0	52.2	42.4	0.1	0.3
Gendron	Lesse	5.8	38.6	55.5	0.1	0.0
Martinrive	Ambleve	8.0	42.8	48.0	1.0	0.3
Salzinnes	Sambre	17.0	64.3	18.3	0.1	0.3
Tabreux	Ourthe	6.3	48.0	45.4	0.3	0.0
Membre	Semois	5.7	38.0	56.2	0.0	0.0
Stah	Roer	18.1	47.0	33.6	0.4	0.9
Meerssen	Geul	17.3	69.1	13.6	0.0	0.0
Goch	Niers	22.2	68.2	8.7	0.0	0.9
Borgharen remainder	None	20.8	58.4	19.9	0.0	0.8
Roermond remainder	None	22.2	57.3	19.1	0.0	1.4
Gennep remainder	None	20.5	59.0	19.1	0.1	1.3

4.5 Precipitation statistics

The precipitation statistics are derived from ”E-OBS daily gridded meteorological data for Europe from 1950 to present derived from in-situ observations”. Three characteristics are displayed to provide insight in the precipitation:

- The average daily precipitation, per month and catchment.
- The average precipitation sum per year, per catchment.
- Intensity duration frequency curves.

4.5.1 Average daily precipitation per month and catchment

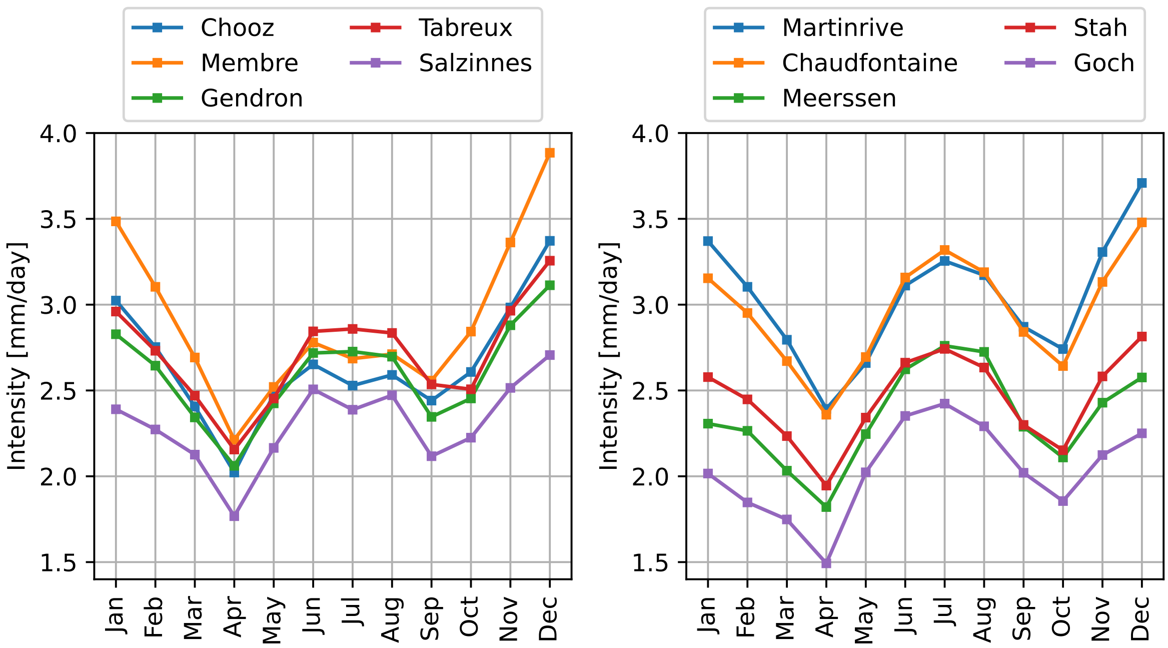

Figure 4.5 Average daily precipitation sum per month, for different subcatchments of the Meuse

4.5.2 Yearly precipitation sum per subcatchment

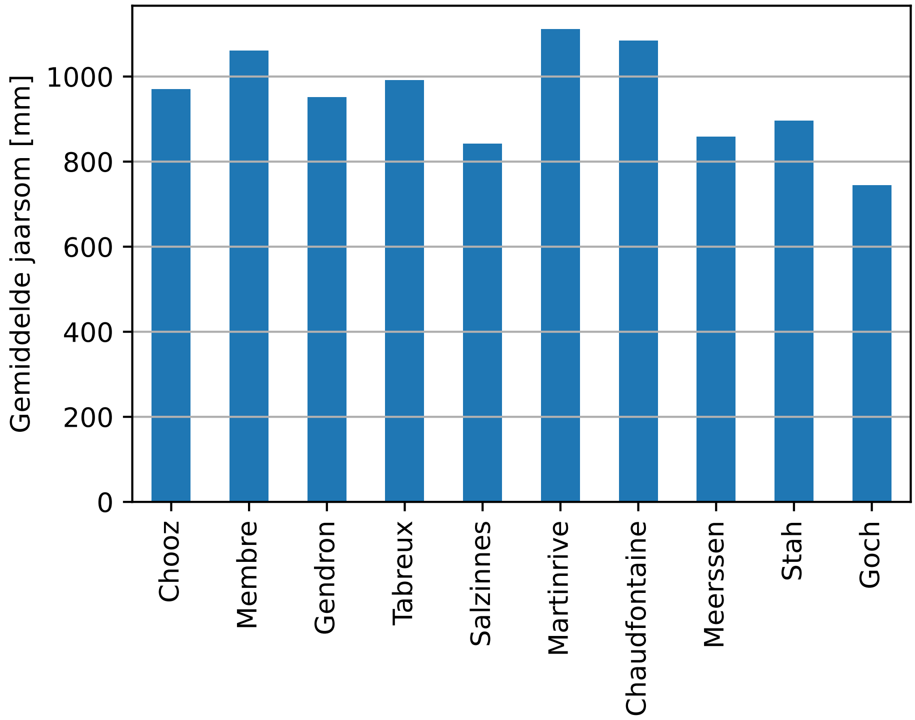

Figure 4.6 Average precipitation sum per year, for the different sub catchments of the Meuse

4.5.3 Intensity-duration-frequency curves per subcatchment

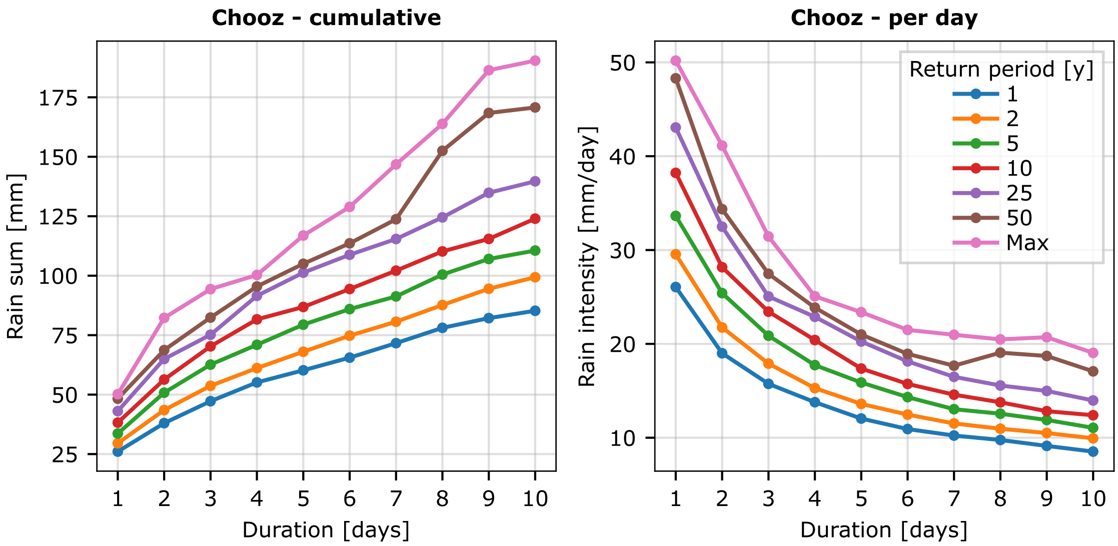

Figure 4.7 Intensity (left) en precipitation sum (right) for different durations and return periods, for the catchment of the French Meuse

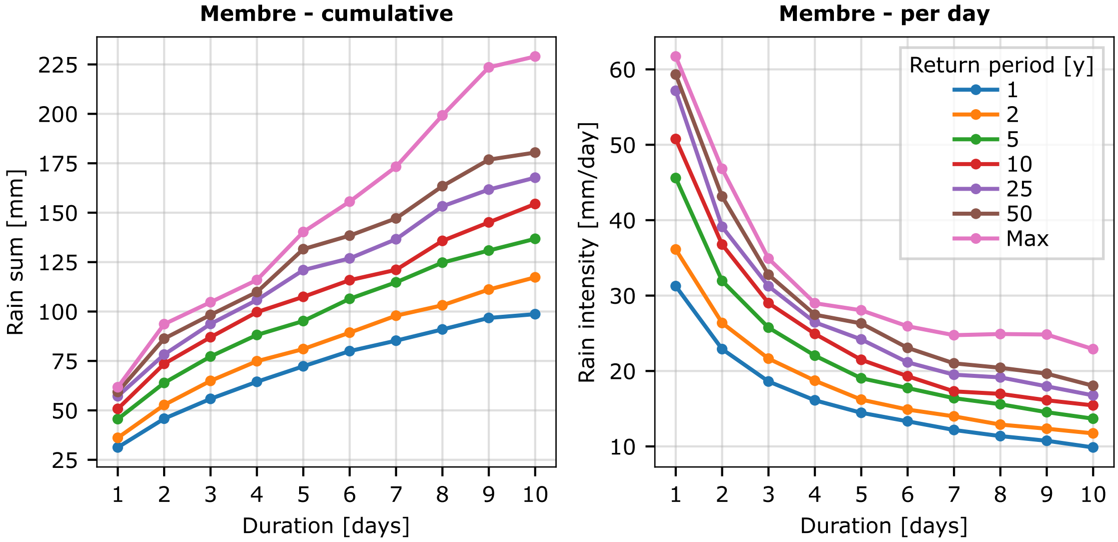

Figure 4.8 Intensity (left) en precipitation sum (right) for different durations and return periods, for the catchment of the Semois

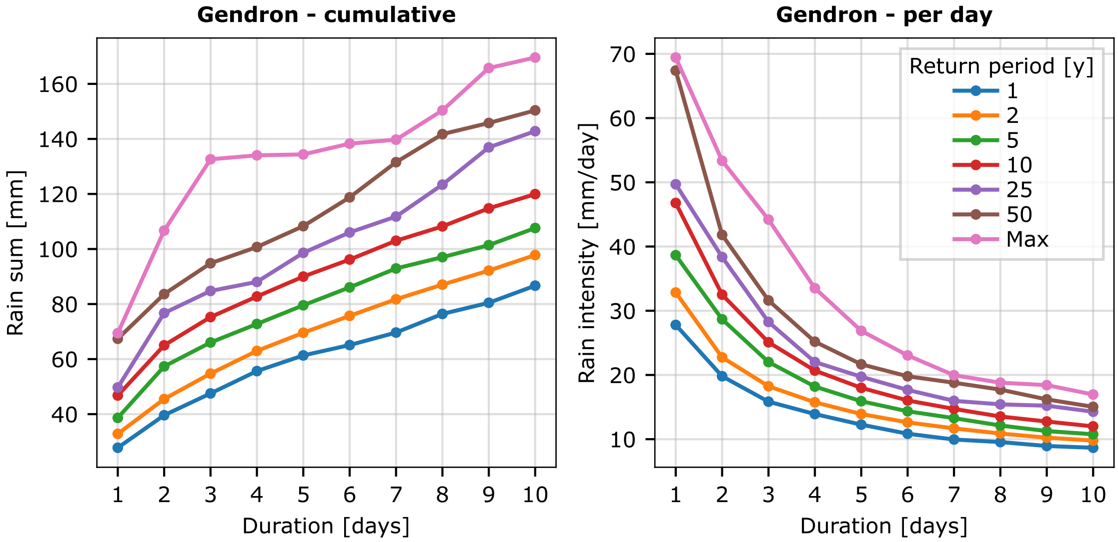

Figure 4.9 Intensity (left) en precipitation sum (right) for different durations and return periods, for the catchment of the Lesse

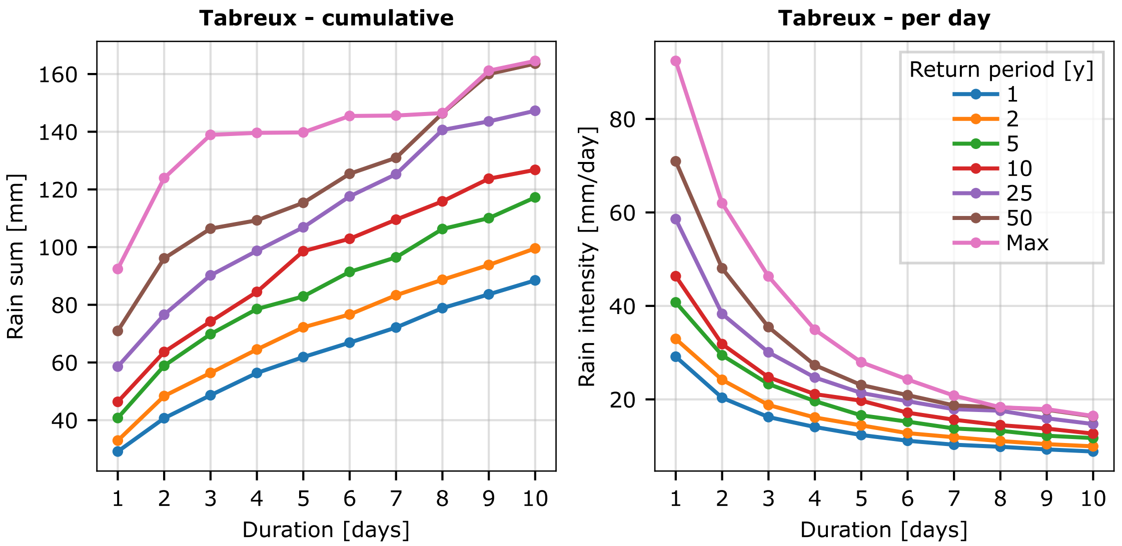

Figure 4.10 Intensity (left) en precipitation sum (right) for different durations and return periods, for the catchment of the Ourthe

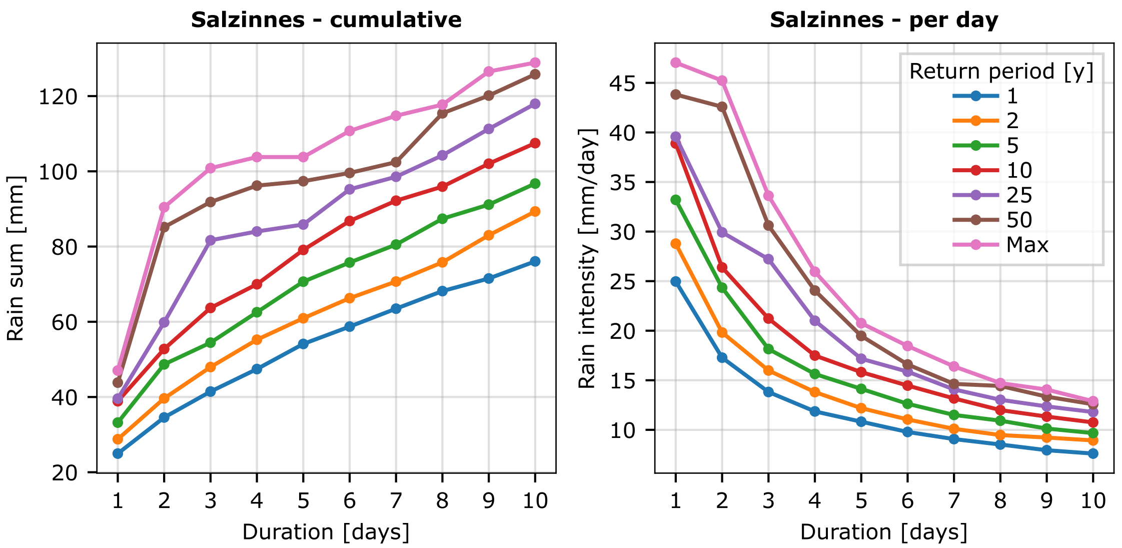

Figure 4.11 Intensity (left) en precipitation sum (right) for different durations and return periods, for the catchment of the Sambre

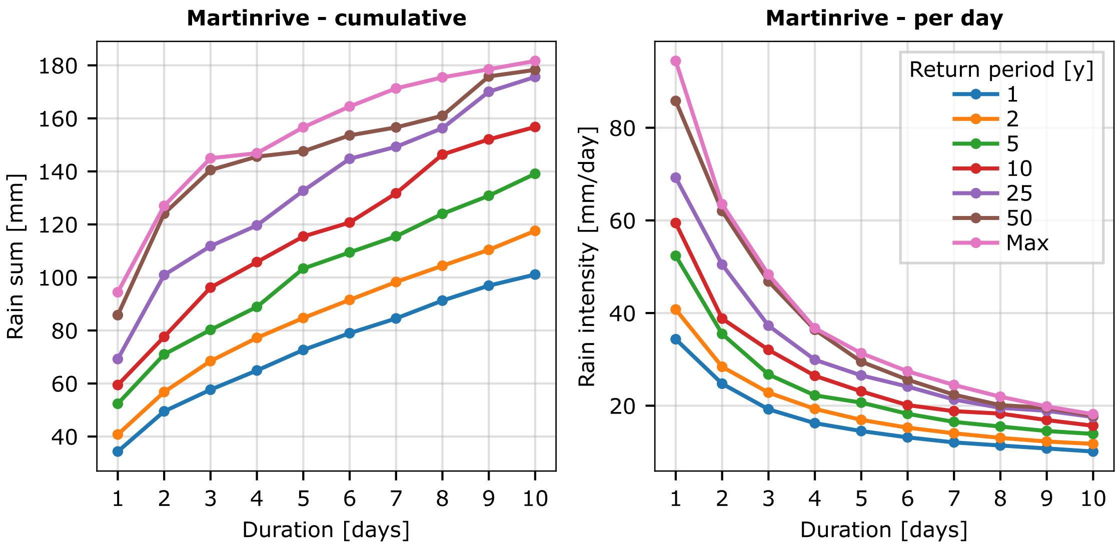

Figure 4.12 Intensity (left) en precipitation sum (right) for different durations and return periods, for the catchment of the Ambleve

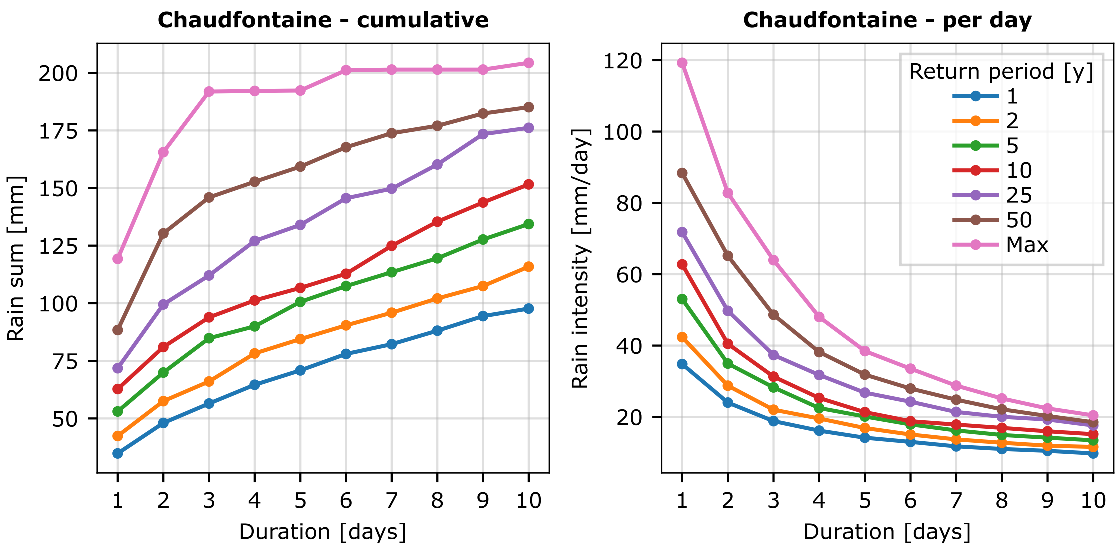

Figure 4.13 Intensity (left) en precipitation sum (right) for different durations and return periods, for the catchment of the Vesdre

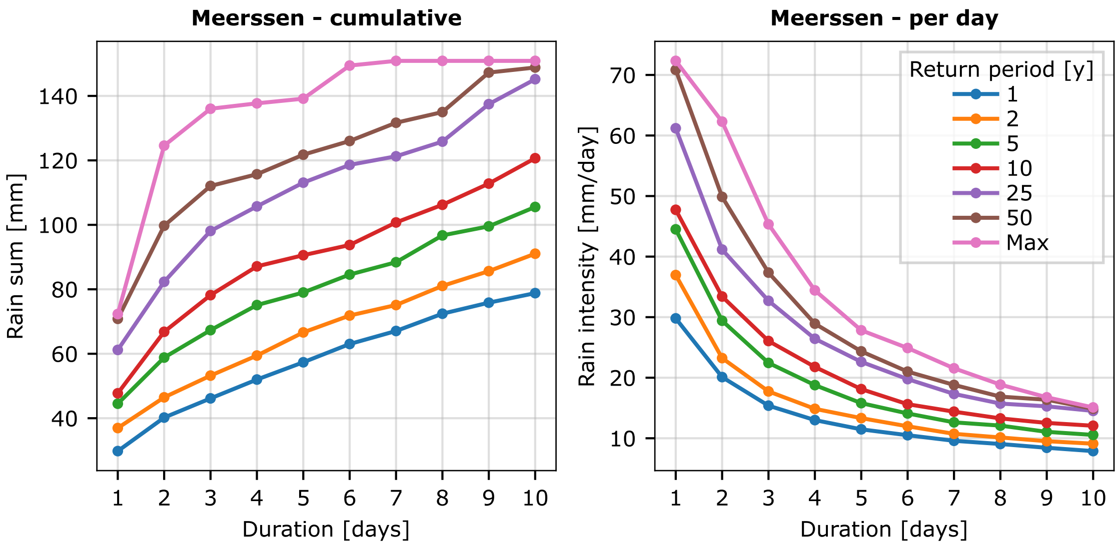

Figure 4.14 Intensity (left) en precipitation sum (right) for different durations and return periods, for the catchment of the Geul

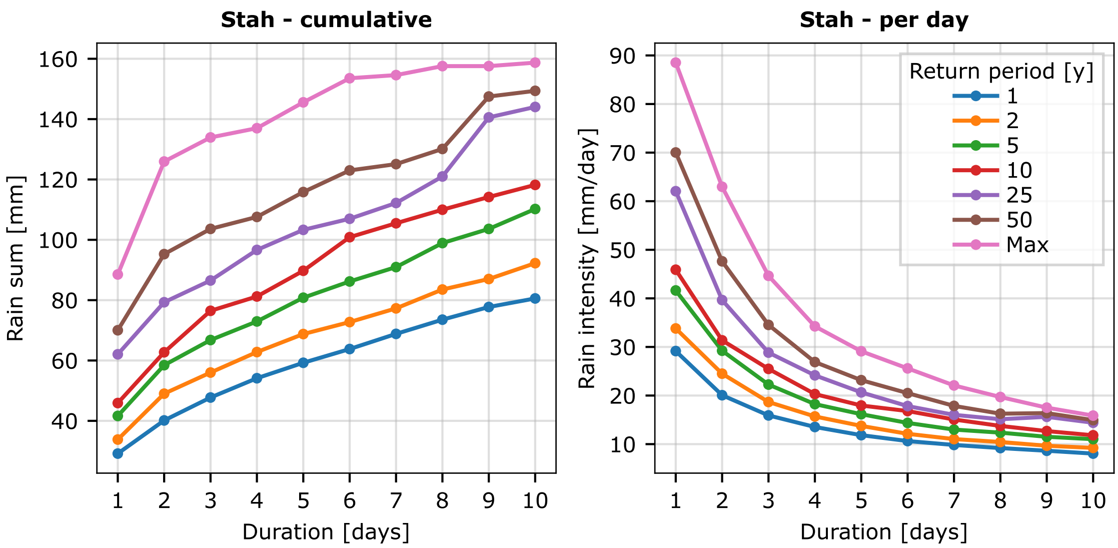

Figure 4.15 Intensity (left) en precipitation sum (right) for different durations and return periods, for the catchment of the Roer

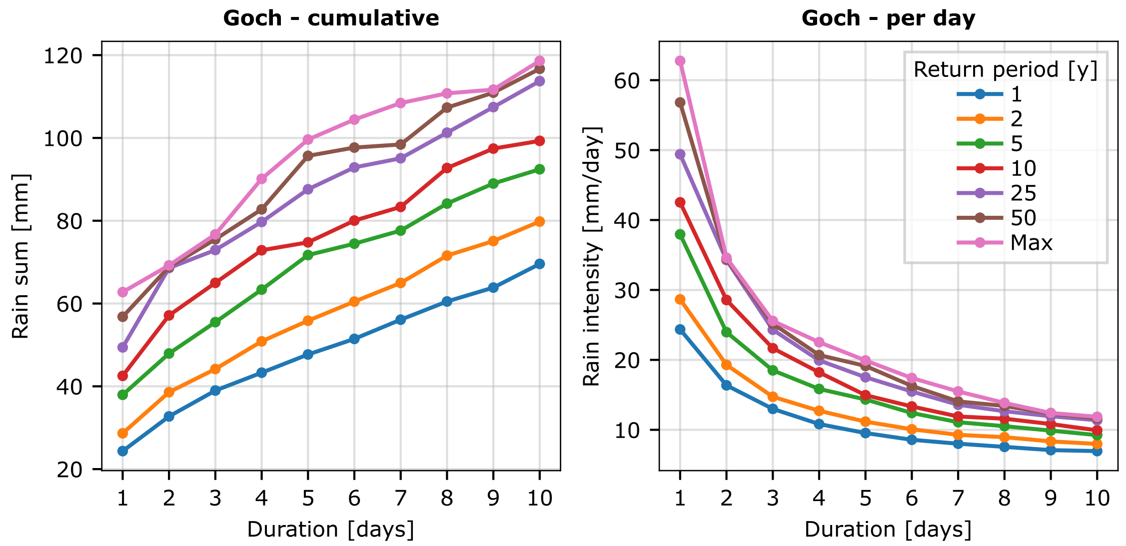

Figure 4.16 Intensity (left) en precipitation sum (right) for different durations and return periods, for the catchment of the Niers

4.6 Precipitation and hydrographs

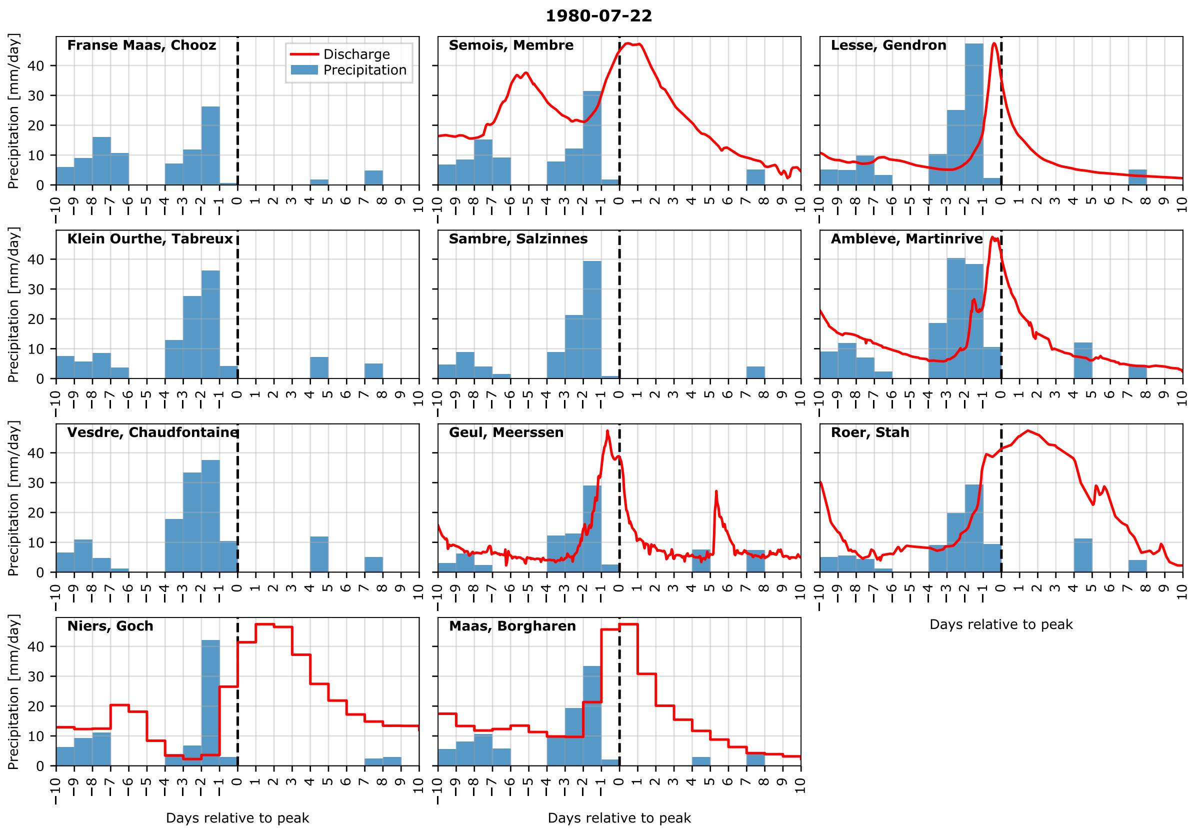

Figure 4.17 Precipitation and hydrographs for the 1980-07-22 high discharge event on the Meuse

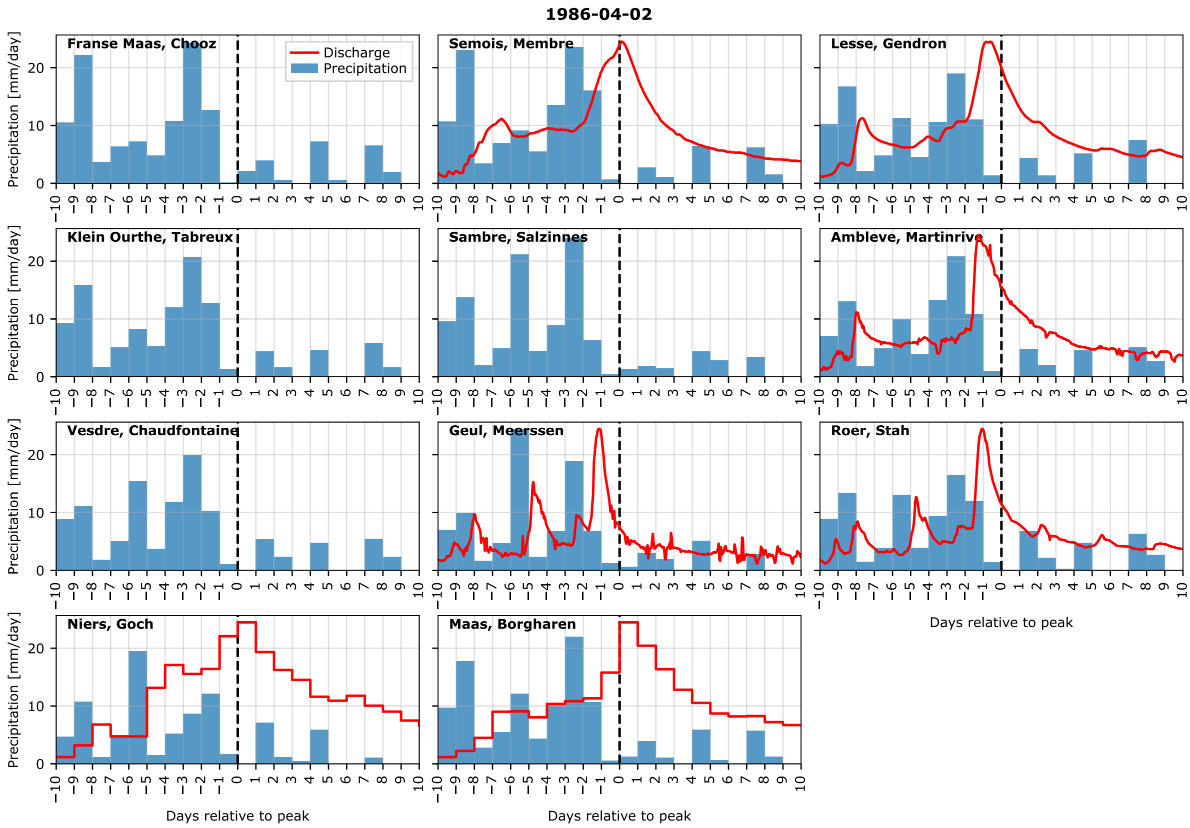

Figure 4.18 Precipitation and hydrographs for the 1986-04-02 high discharge event on the Meuse

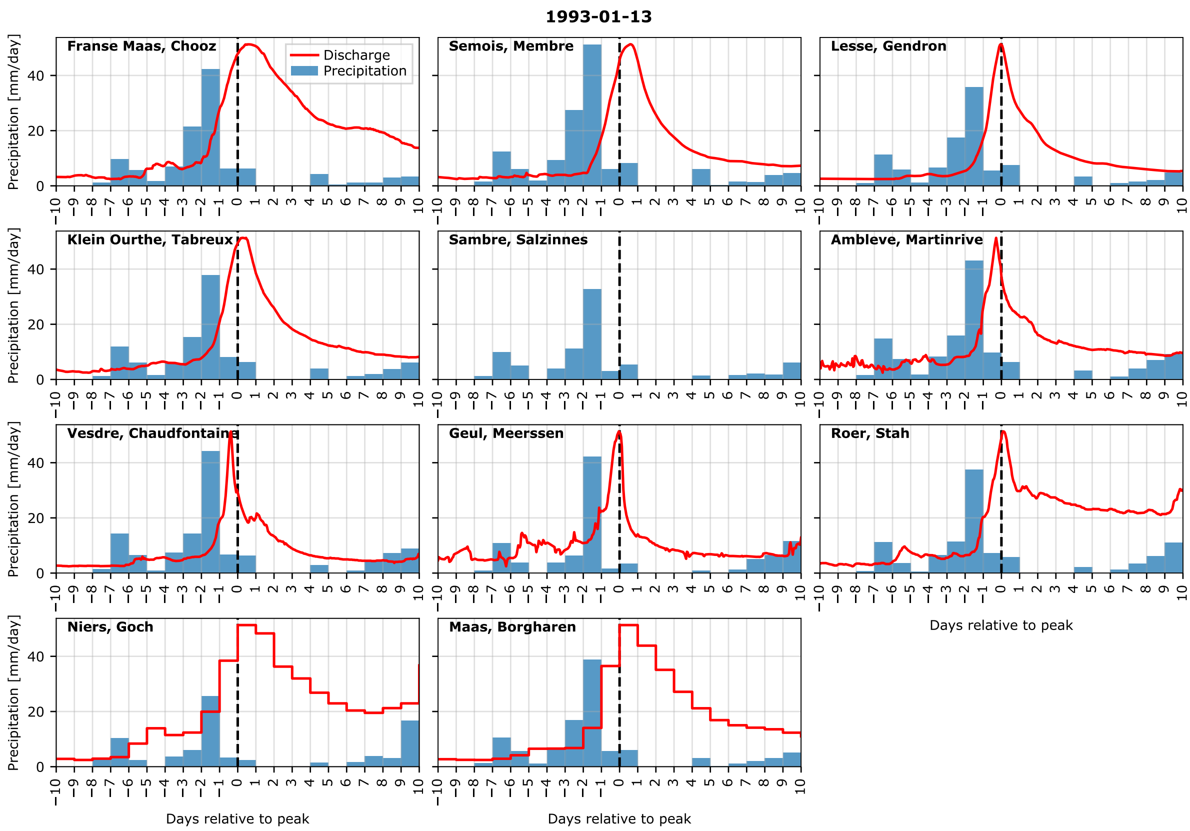

Figure 4.19 Precipitation and hydrographs for the 1993-01-13 high discharge event on the Meuse

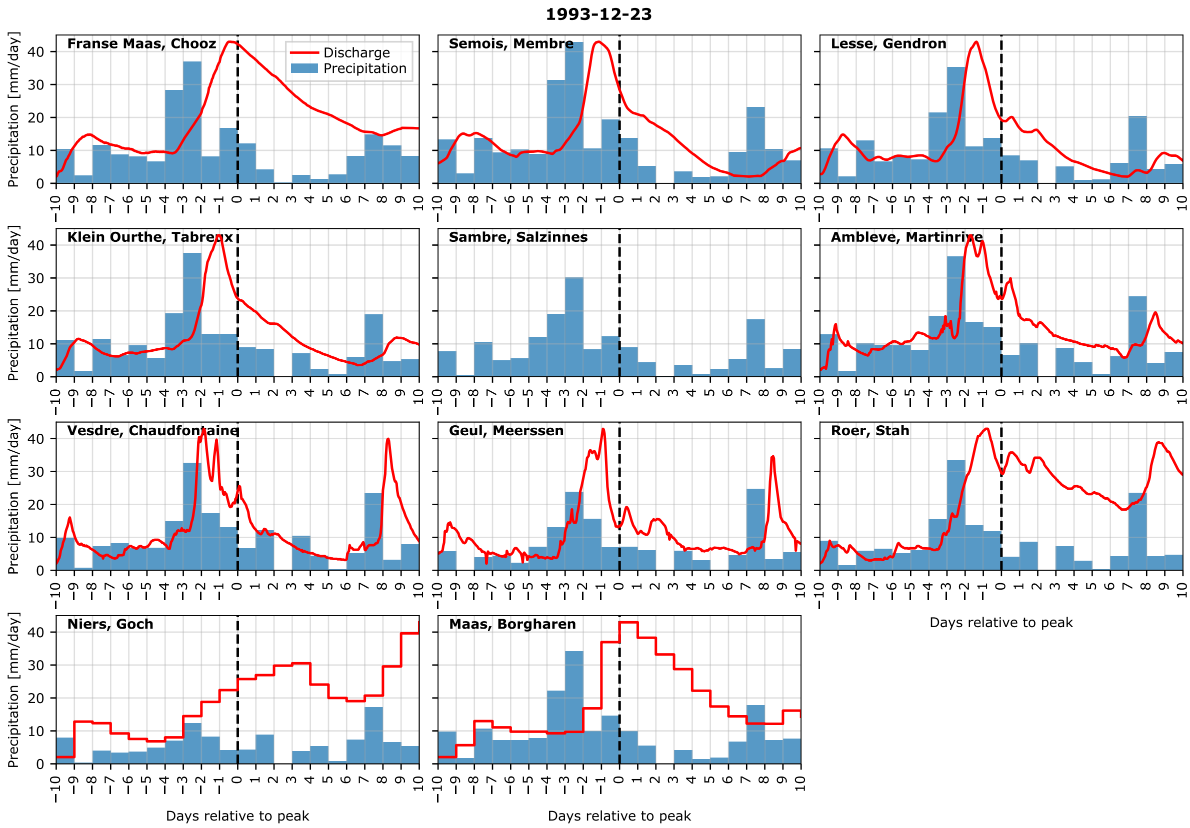

Figure 4.20 Precipitation and hydrographs for the 1993-12-23 high discharge event on the Meuse

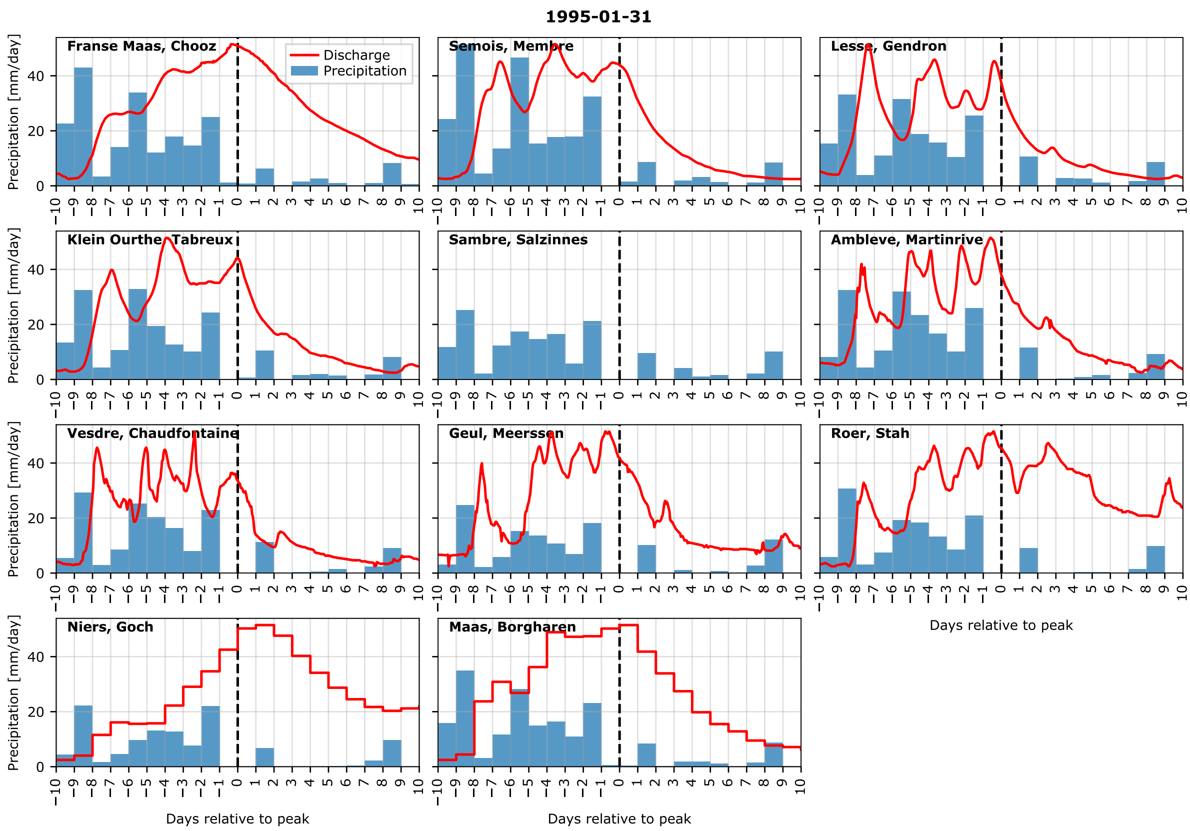

Figure 4.21 Precipitation and hydrographs for the 1995-01-31 high discharge event on the Meuse

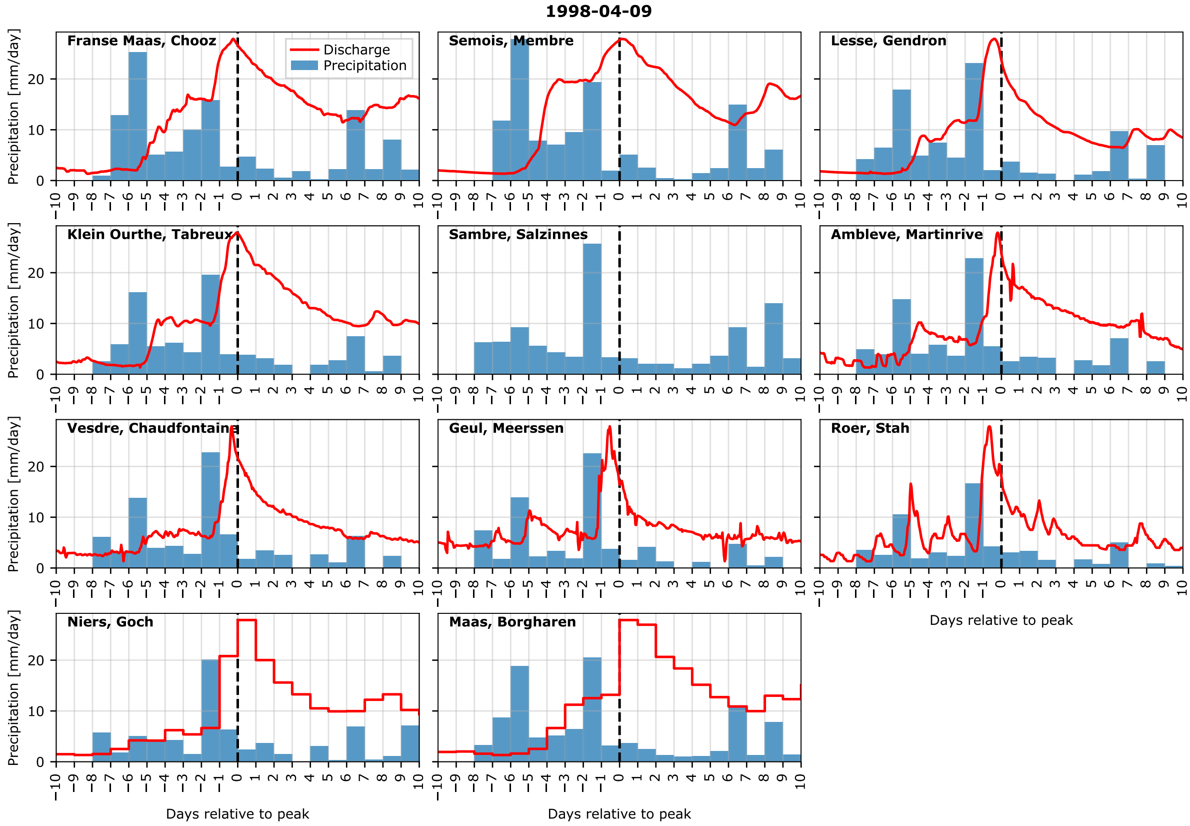

Figure 4.22 Precipitation and hydrographs for the 1998-04-09 high discharge event on the Meuse

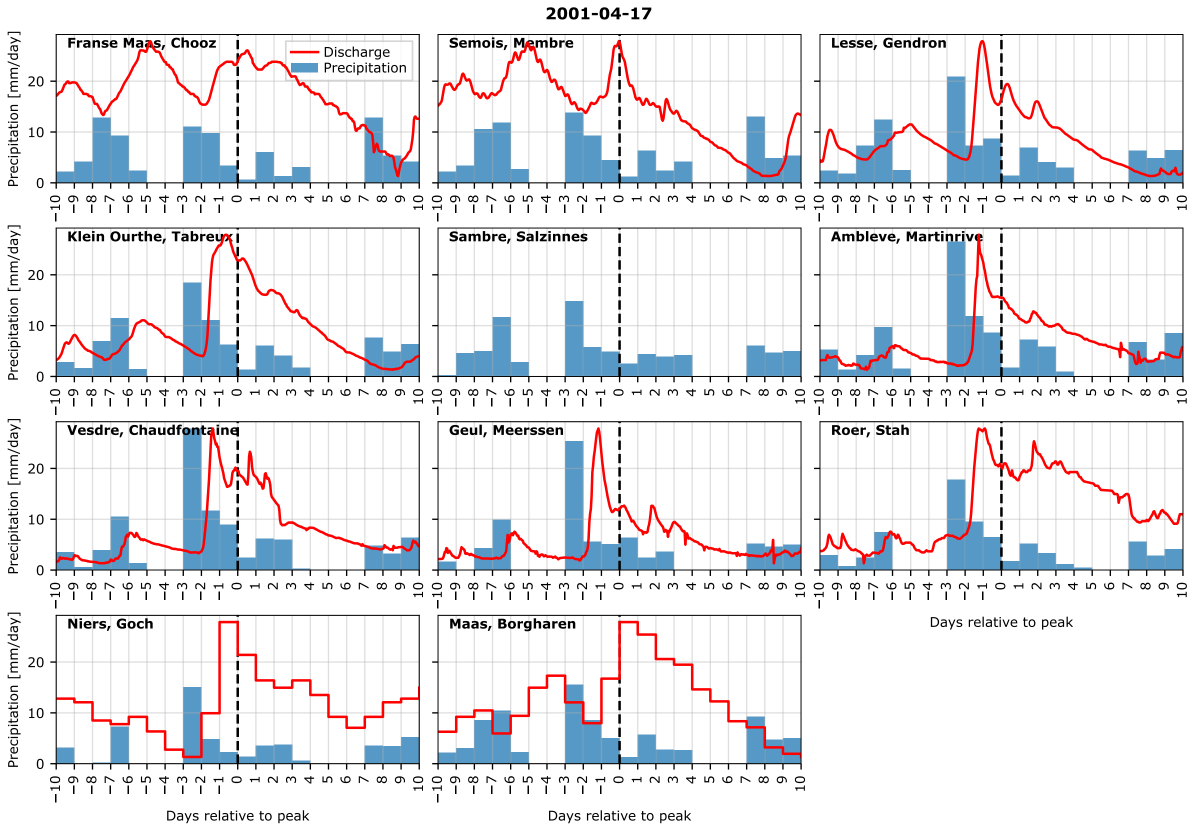

Figure 4.23 Precipitation and hydrographs for the 2001-04-17 high discharge event on the Meuse

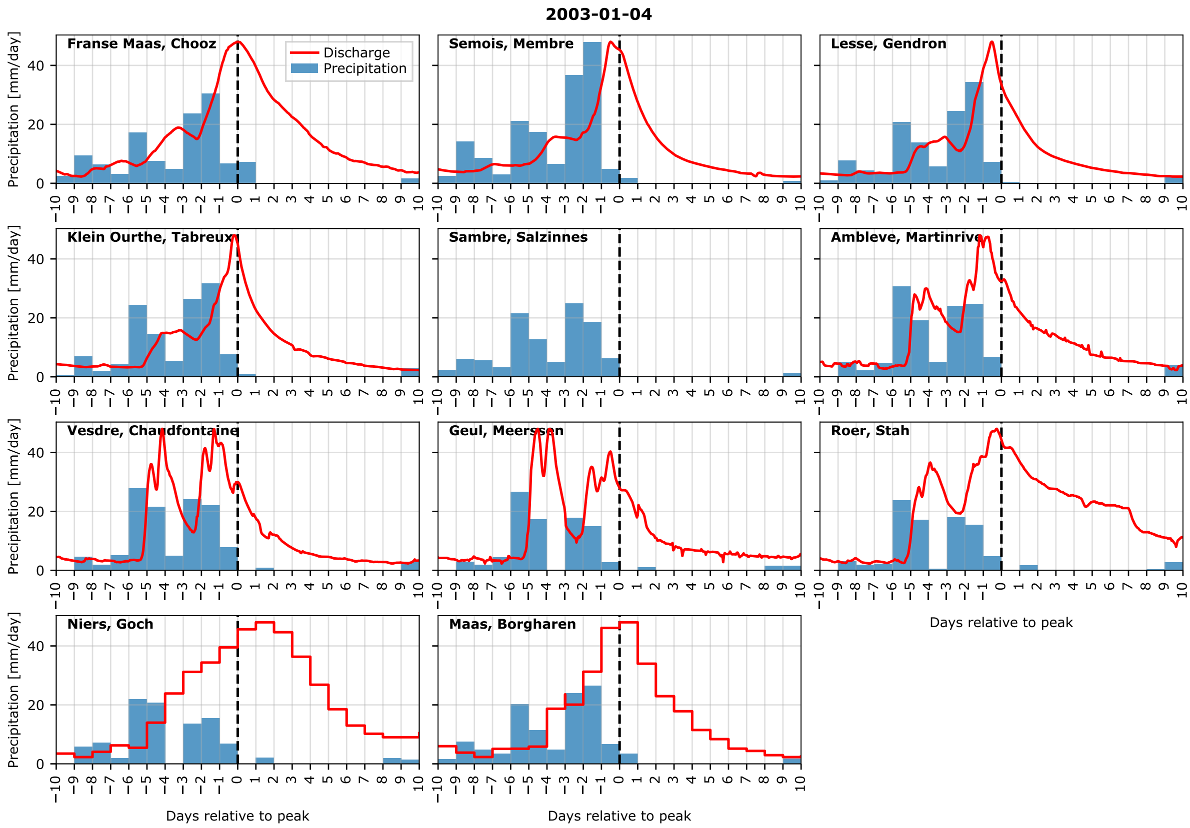

Figure 4.24 Precipitation and hydrographs for the 2003-01-04 high discharge event on the Meuse

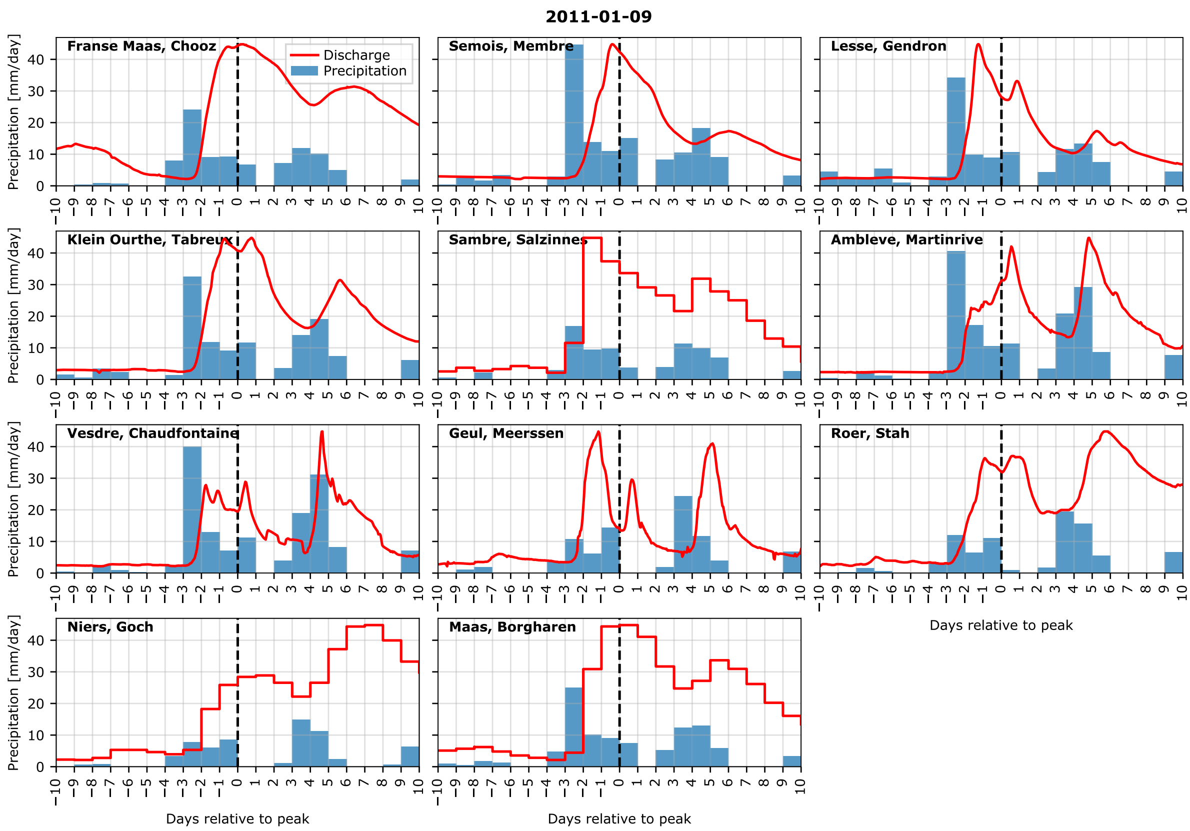

Figure 4.25 Precipitation and hydrographs for the 2011-01-09 high discharge event on the Meuse

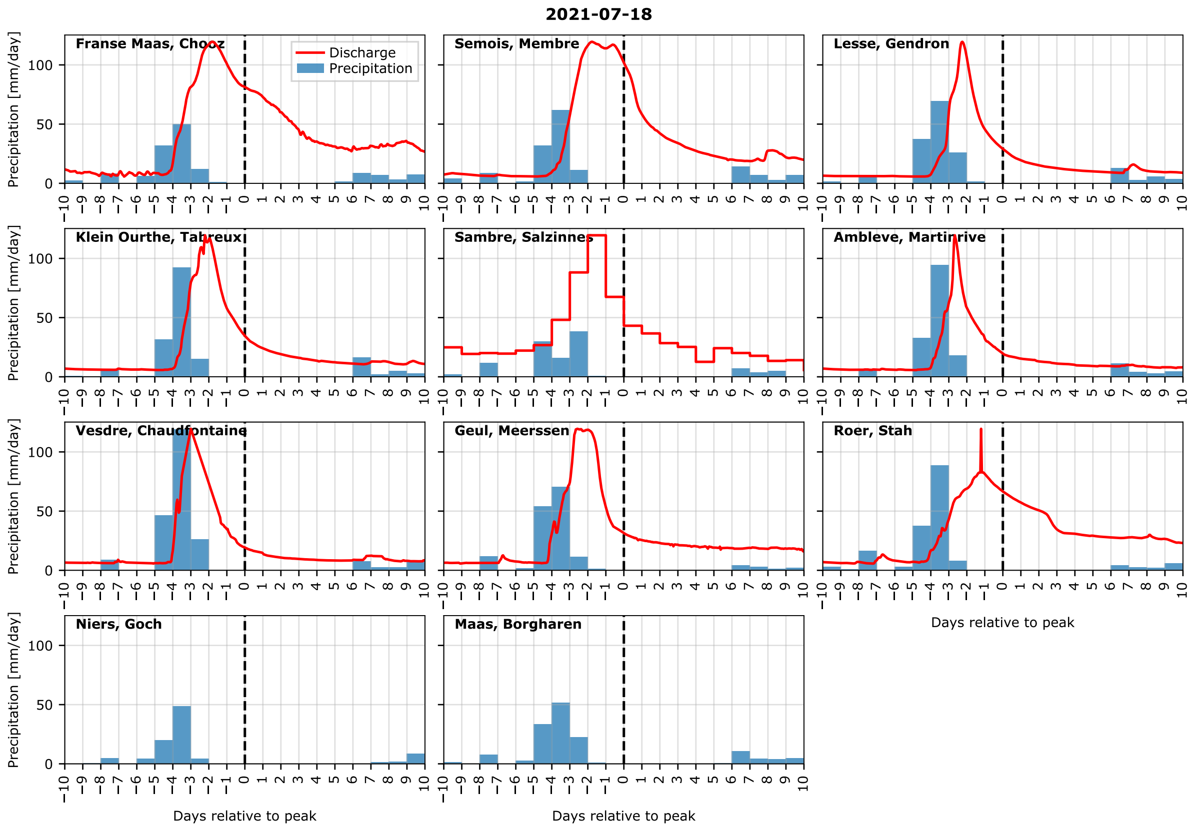

Figure 4.26 Precipitation and hydrographs for the 2021-07-18 high discharge event on the Meuse