



Supplement of

Rain-on-wet-soil compound floods in lowlands: the combined effect of large rain events and shallow groundwater on discharge peaks in a changing climate

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Section S1

Table S1. Information about the calibration and validation procedure and performance.

No.	Catchment	Calibration		Validation		Method	Reference
		Period	NSE	Period	NSE		
1	Hupsel Brook	01-11-2011 – 30-10-2012	0.87	01-11-2012 – 30-10-2013	0.77	PSO	Brauer et al. (2014b)
2	Steinfurter Aa	01-04-2006 – 31-03-2007	0.75	01-04-2007 – 31-03-2008	0.75	MCS → DVI → LMO	Loos (2015)
3	Luntersebeek	01-04-2011 – 31-03-2012	0.75	01-04-2012 – 31-03-2013	0.73	LMO	Meijers (2017)
4	Aa of Weerijds	01-04-2011 – 31-03-2012	0.84	01-04-2012 – 31-03-2013	0.82	LHS → DVI → LMO	This study
5	Ommerkanaal	01-04-2011 – 31-03-2012	0.88	01-04-2012 – 31-03-2013	0.57	MCS → DVI → LMO	Loos (2015)
6	Vechte A	01-04-1998 – 31-03-1999	0.91	01-04-1991 – 31-03-1992	0.89	MCS → DVI → LMO	Loos (2015)
7	Bakelse Aa	01-04-2010 – 31-03-2011	0.94	01-04-2011 – 31-03-2012	0.97	LHS → DVI → LMO	This study
8	Dinkel	01-04-1998 – 31-03-1999	0.87	01-04-1999 – 31-03-2000	0.78	LHS → LMO	This study
9	Grote Waterleiding	01-04-2012 – 31-03-2013	0.79	01-04-2013 – 31-03-2014	0.72	LMO → MVI	Heuvelink (2016)
10	Vecht	01-04-2005 – 31-03-2006	0.60	01-04-2006 – 31-03-2007	0.93	MCS → DVI → LMO	Loos (2015)
11	Lage Raam	01-04-2010 – 31-03-2011	0.82	01-04-2011 – 31-03-2012	0.60	MCS → MVI	NA
12	Radewijkerbeek	01-04-2014 – 31-03-2015	0.82	01-04-2015 – 31-03-2016	0.78	LHS → DVI → LMO	This study

Abbreviations of the methods:

PSO Particle Swarm Optimization

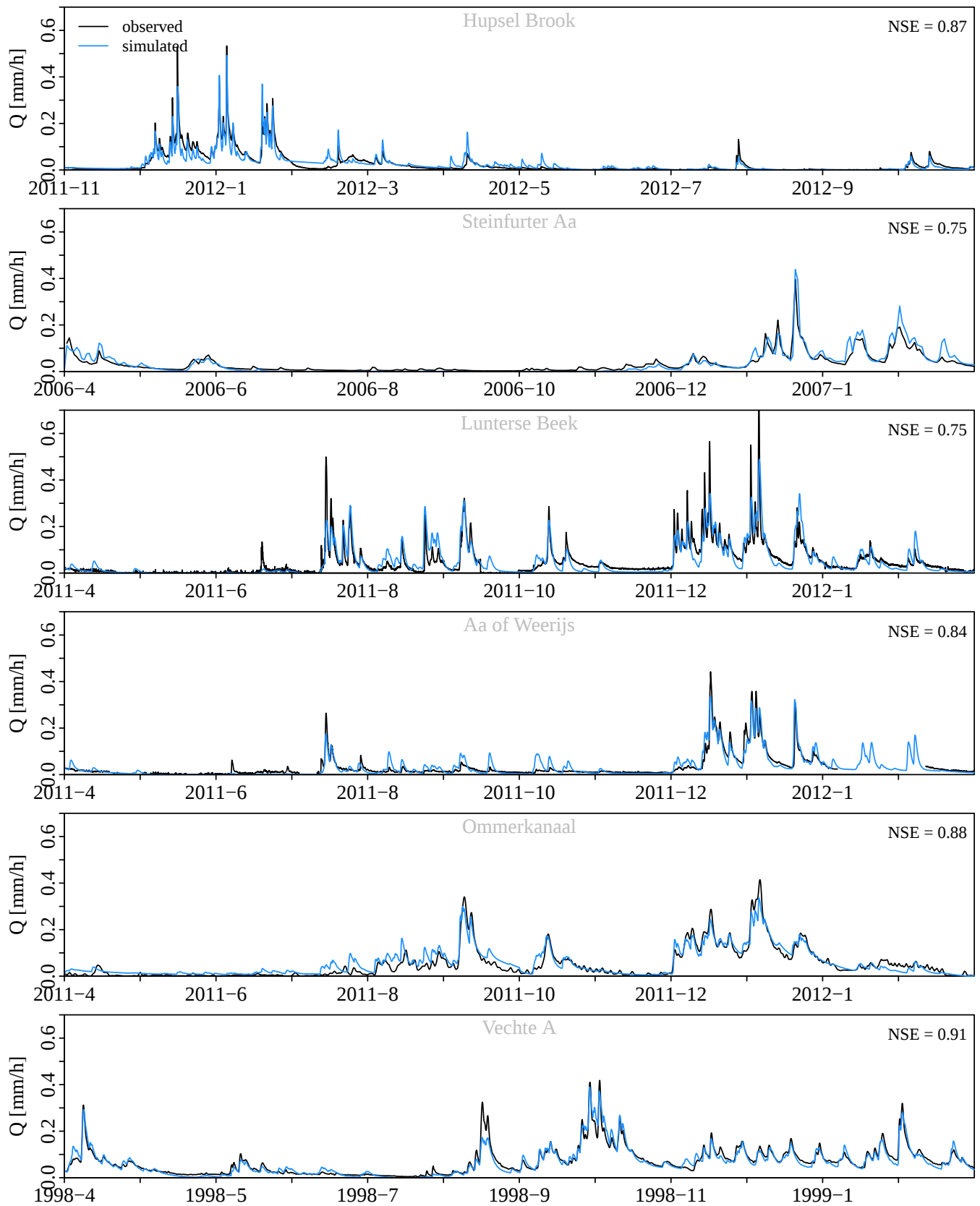
MCS Monte Carlo Sampling

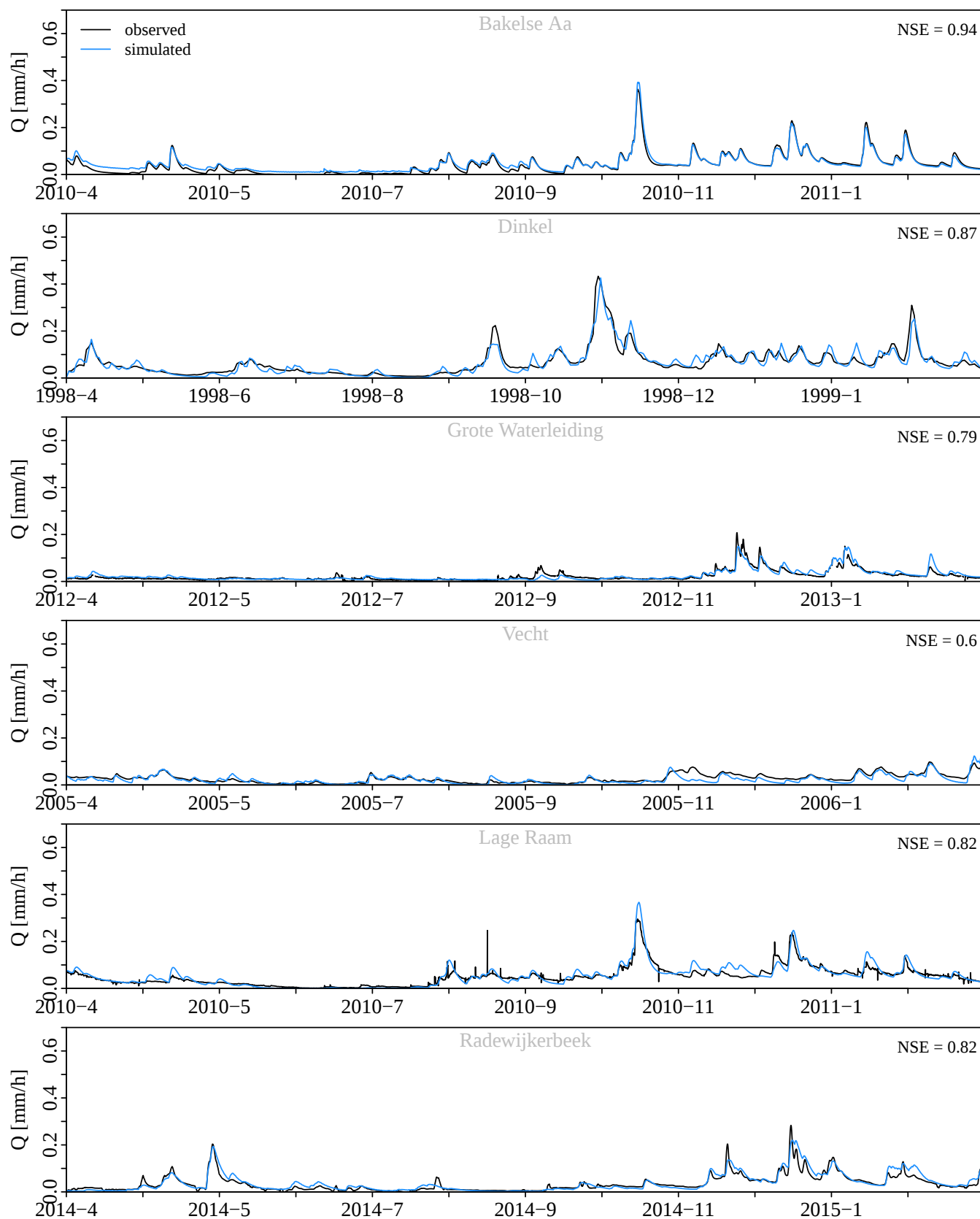
^s **LHS** Latin Hypercube Sampling

LMO Levenberg-Marquardt optimization

DVI Discard parameter sets after visual inspection

MVI Manual optimization with visual inspection

**Figure S1.** Calibration results.

**Figure S2.** Calibration results.

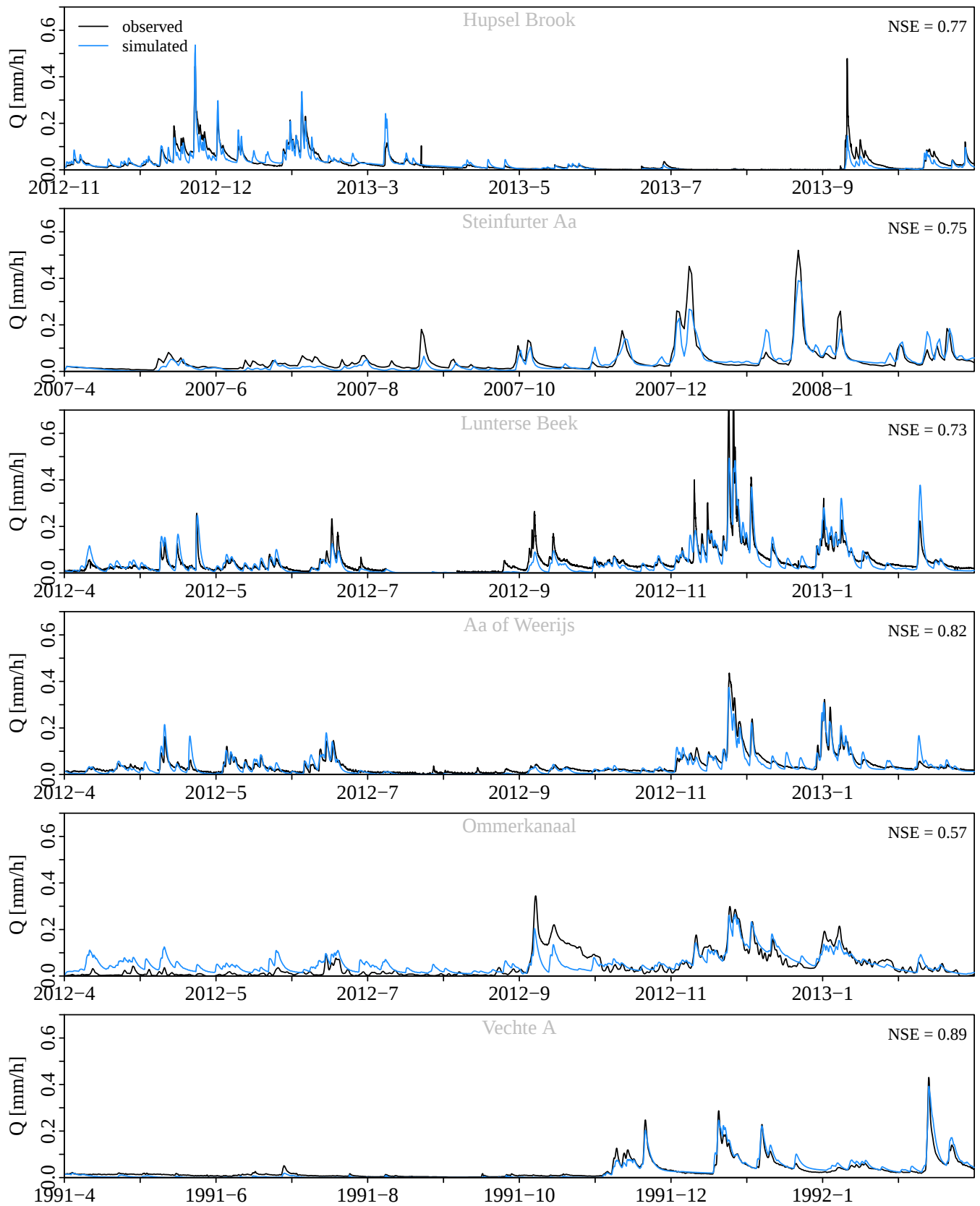
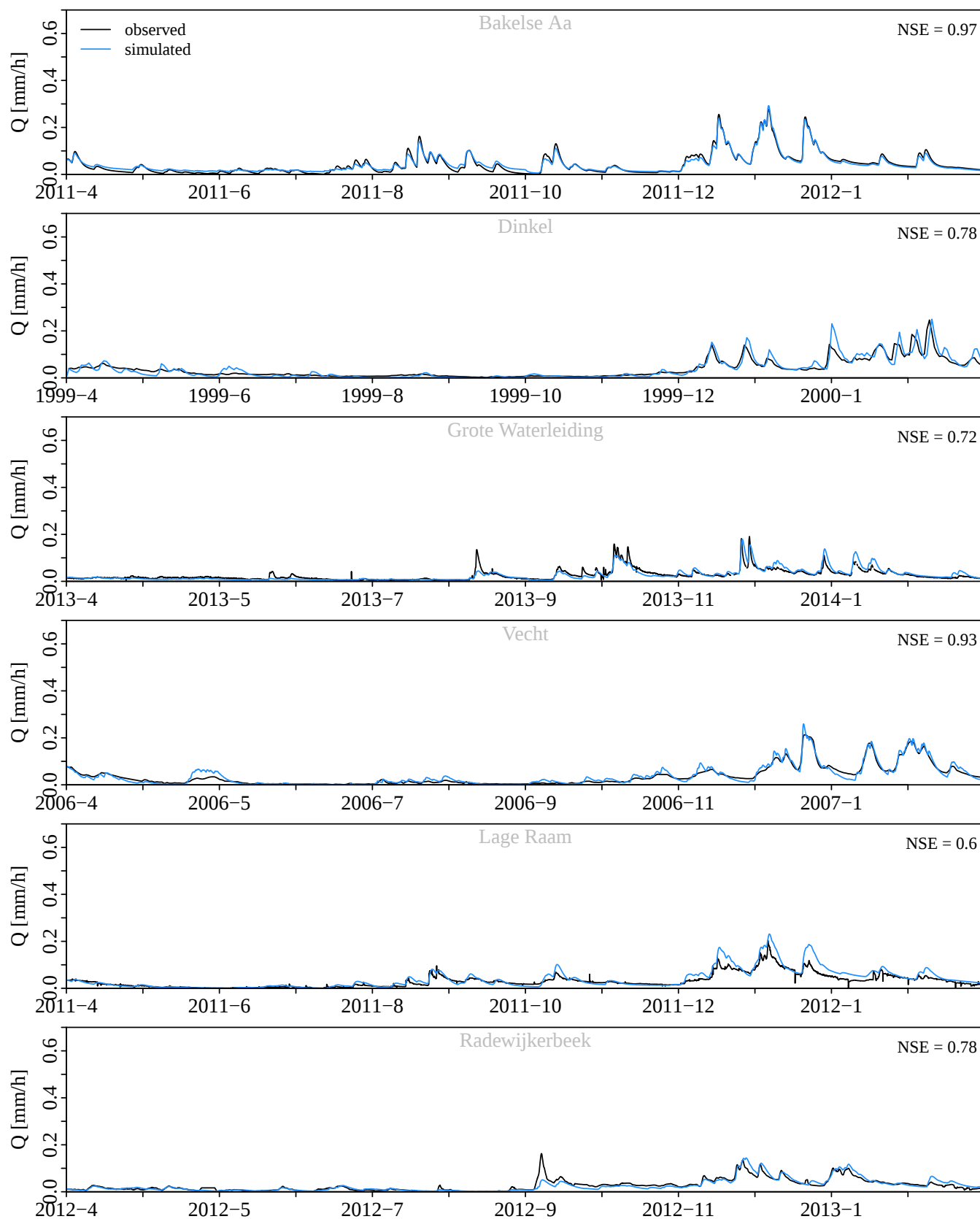


Figure S3. Validation of the discharge simulations.

**Figure S4.** Validation of the discharge simulations.

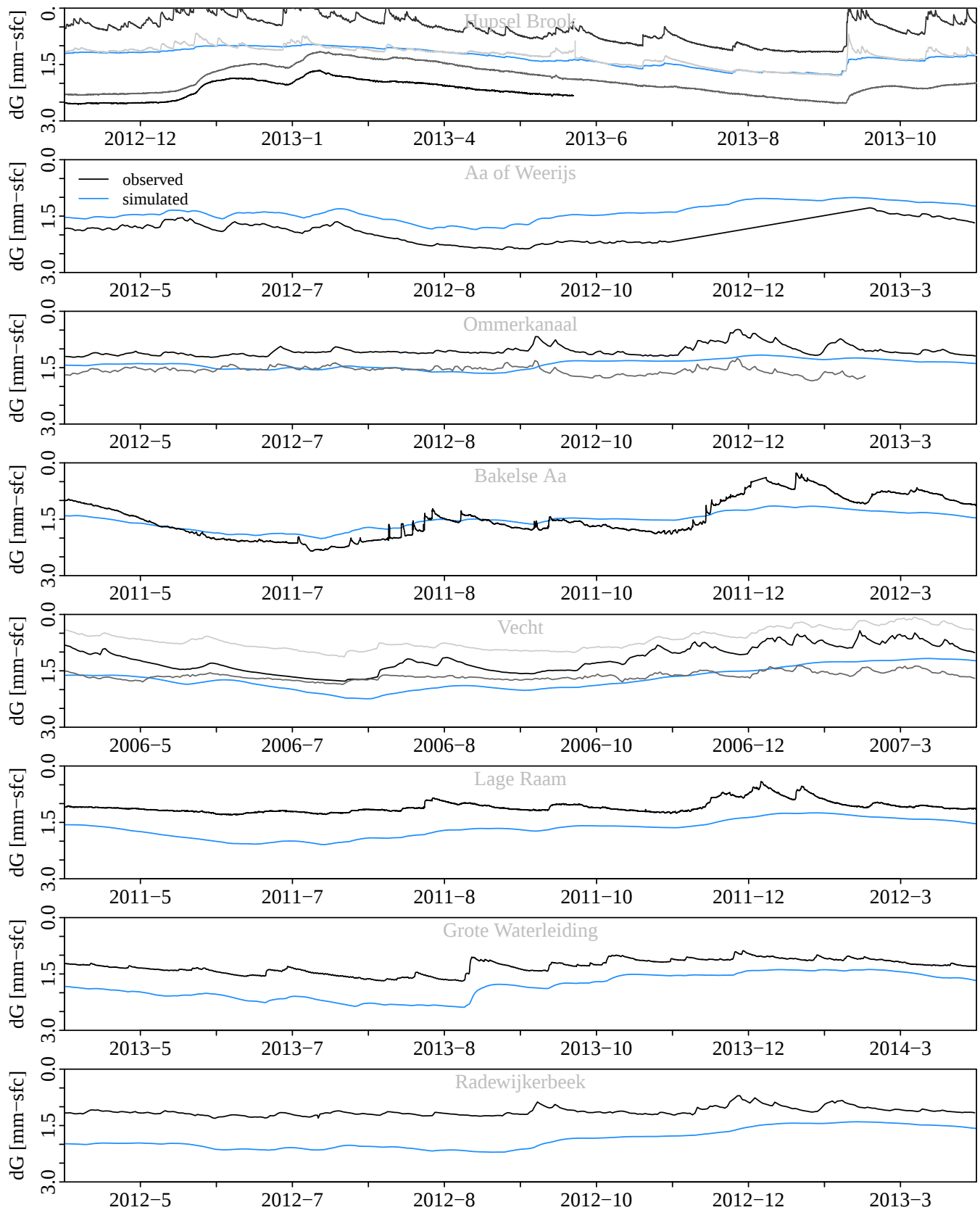


Figure S5. Comparison of groundwater simulations with observations. Observations are from a single or multiple (Ommerkanaal and Vecht) piezometers located in the catchment. For some catchments, no observations were available.

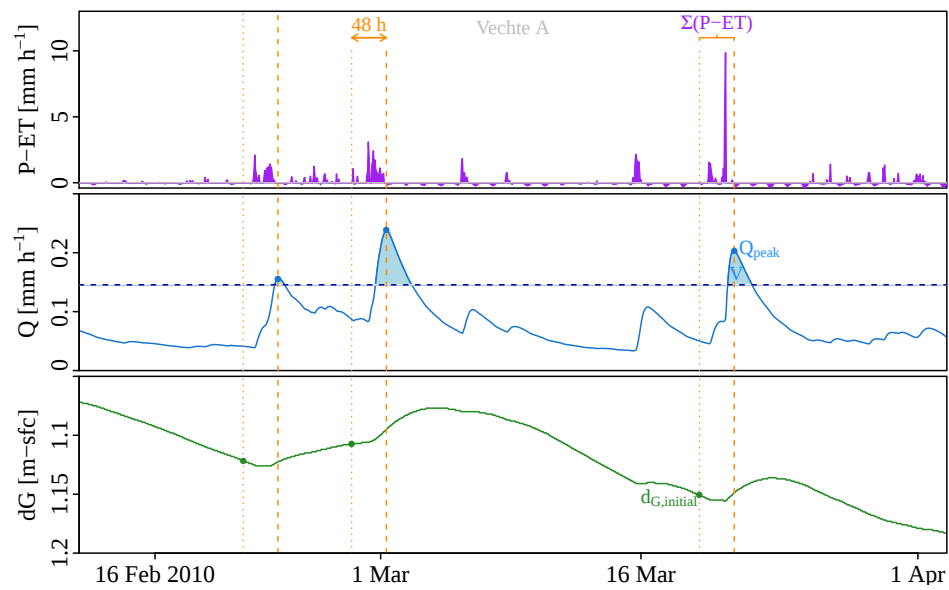


Figure S6. Illustration of the method of computation of the metrics used in this paper.

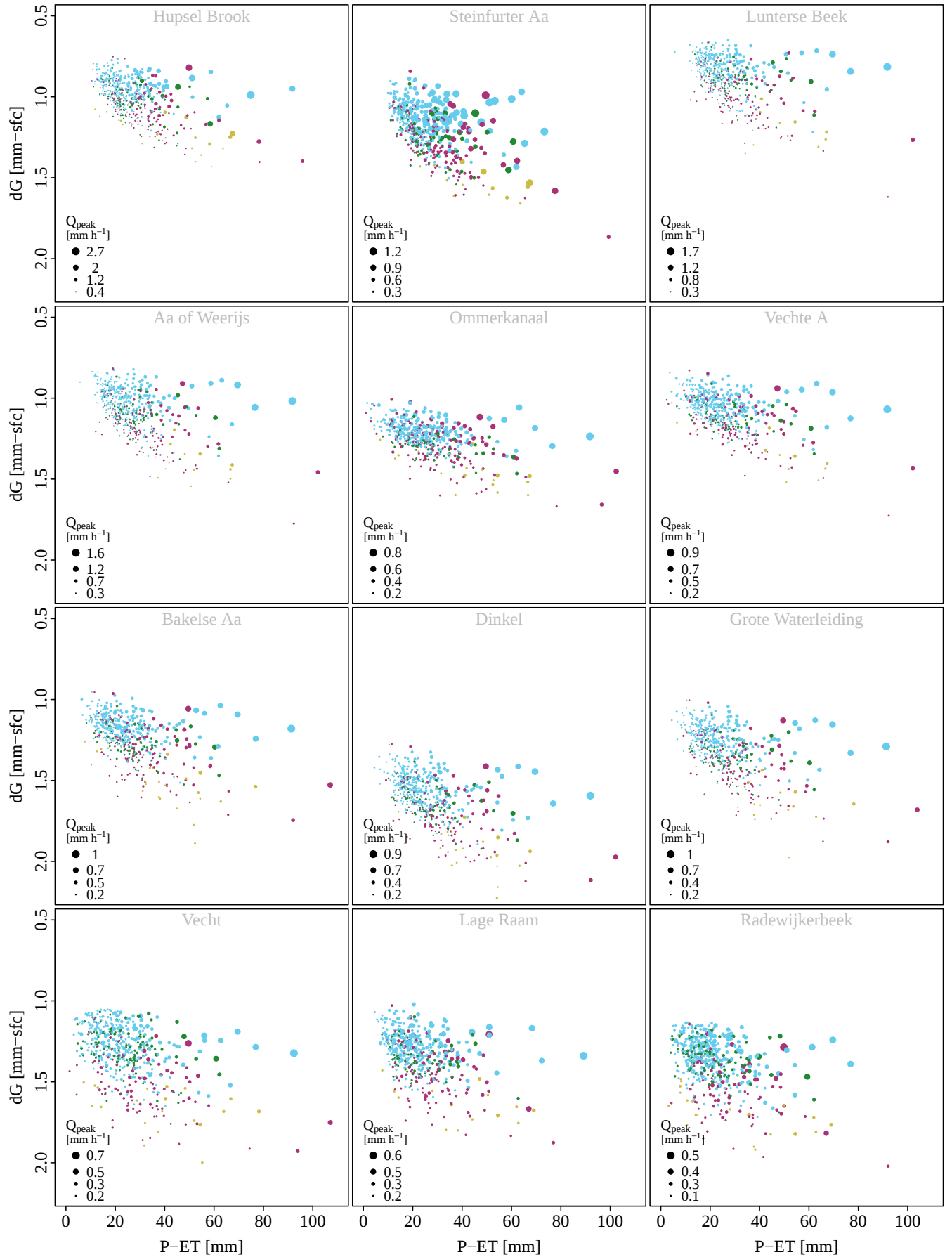


Figure S7. Figure 4 for all catchments.

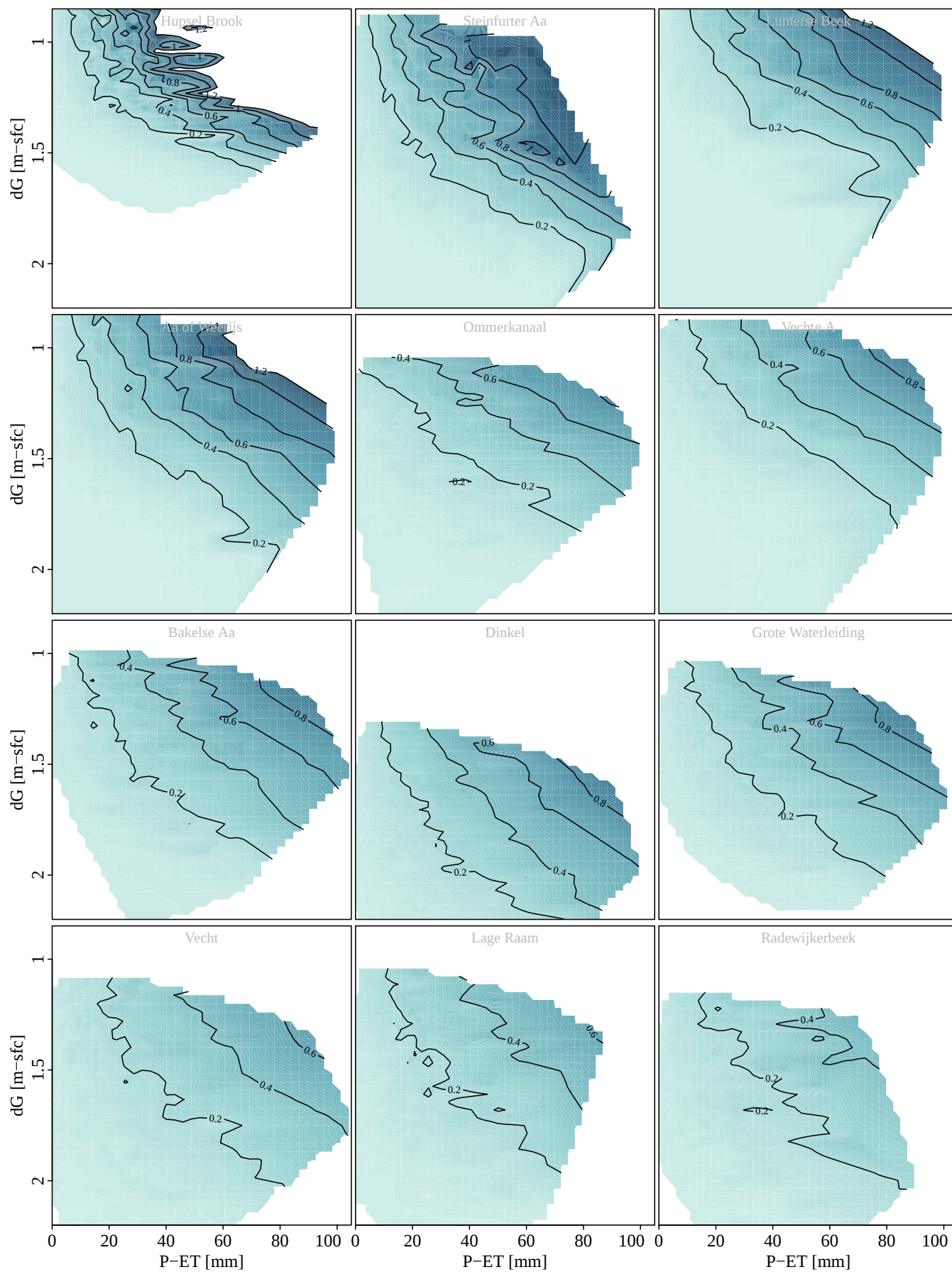


Figure S8. Figure 5 for all catchments. Colours represent the same values as the contour lines and are added to make the figures easier to interpret.

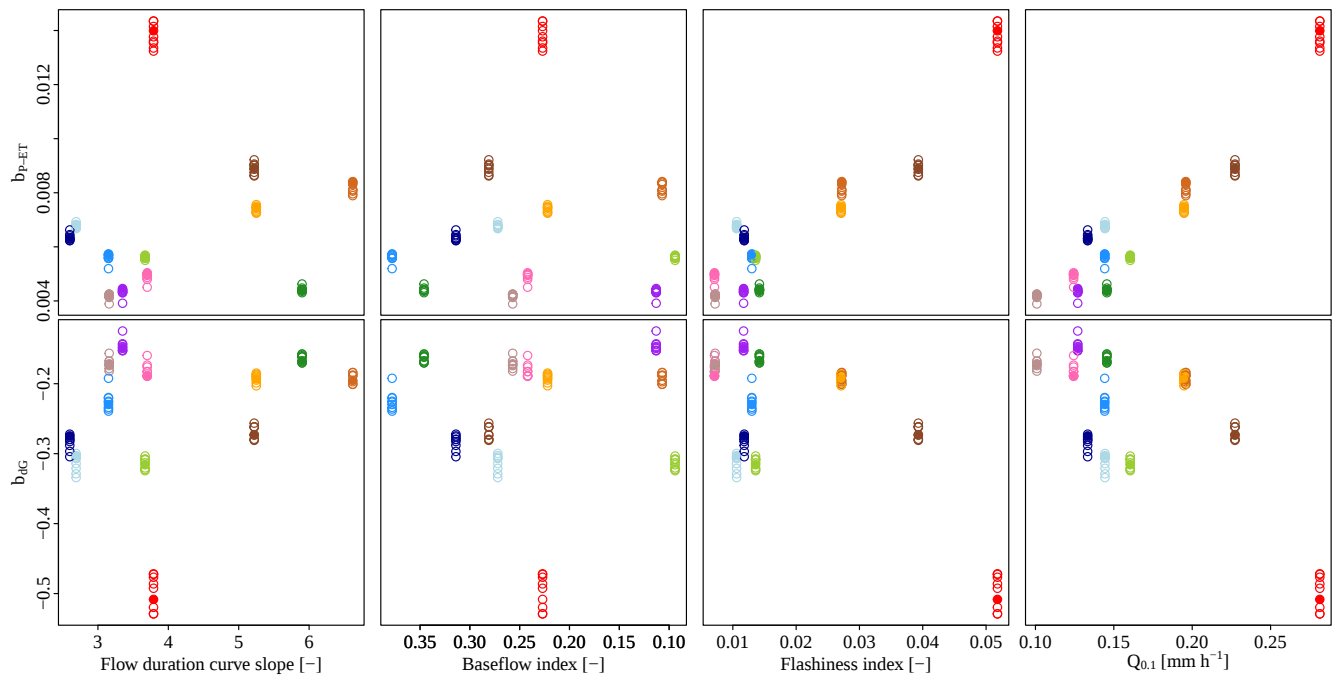


Figure S9. Relation between the regression parameters (Fig. 6) and metrics for discharge dynamics (Fig. 3). Colors are the same for each catchment (same as in Figs. 3 and 6).

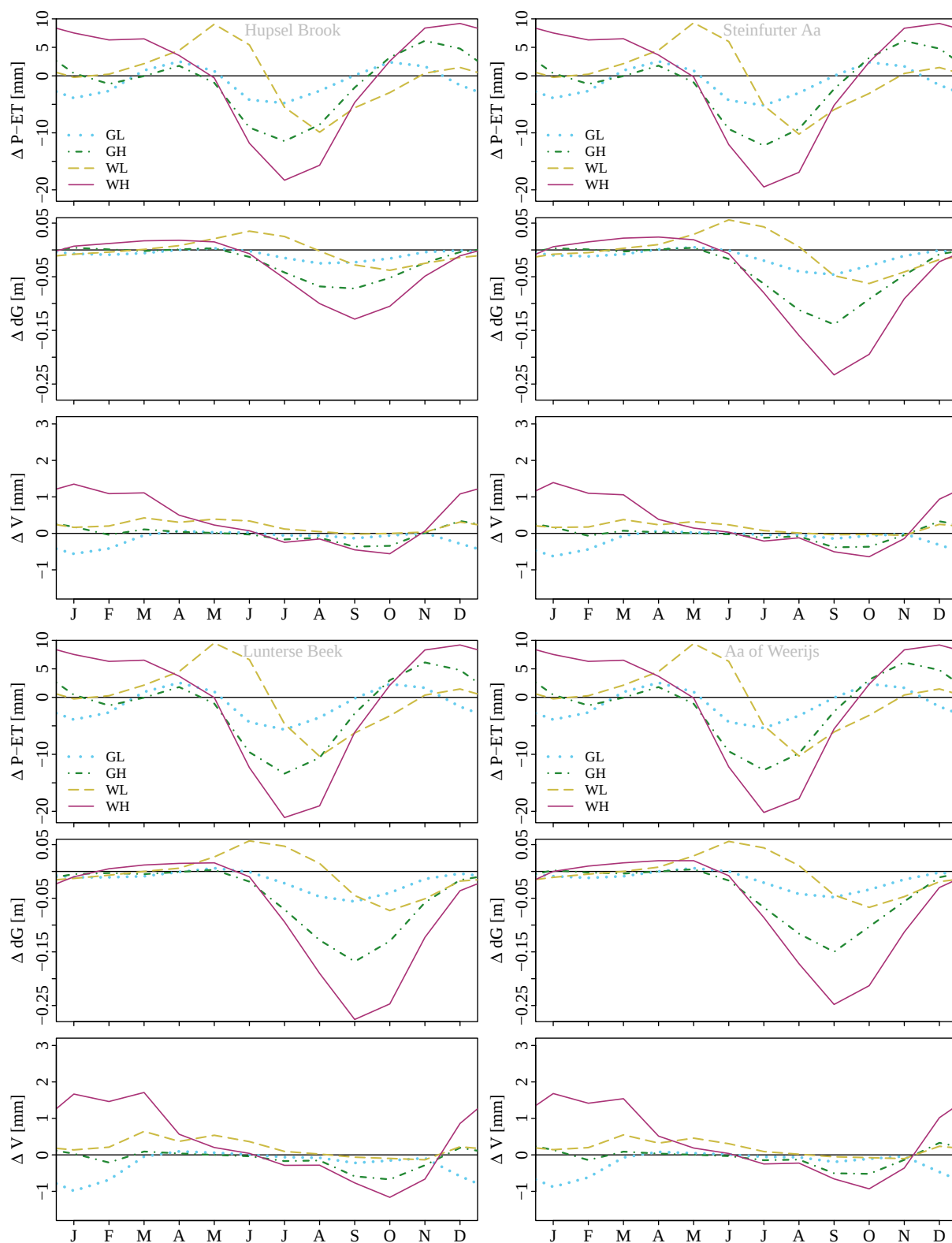


Figure S10. Figure 7 for the Hupsel Brook, Steinfurter Aa, Lunterse Beek and Aa of Weerijis catchments.

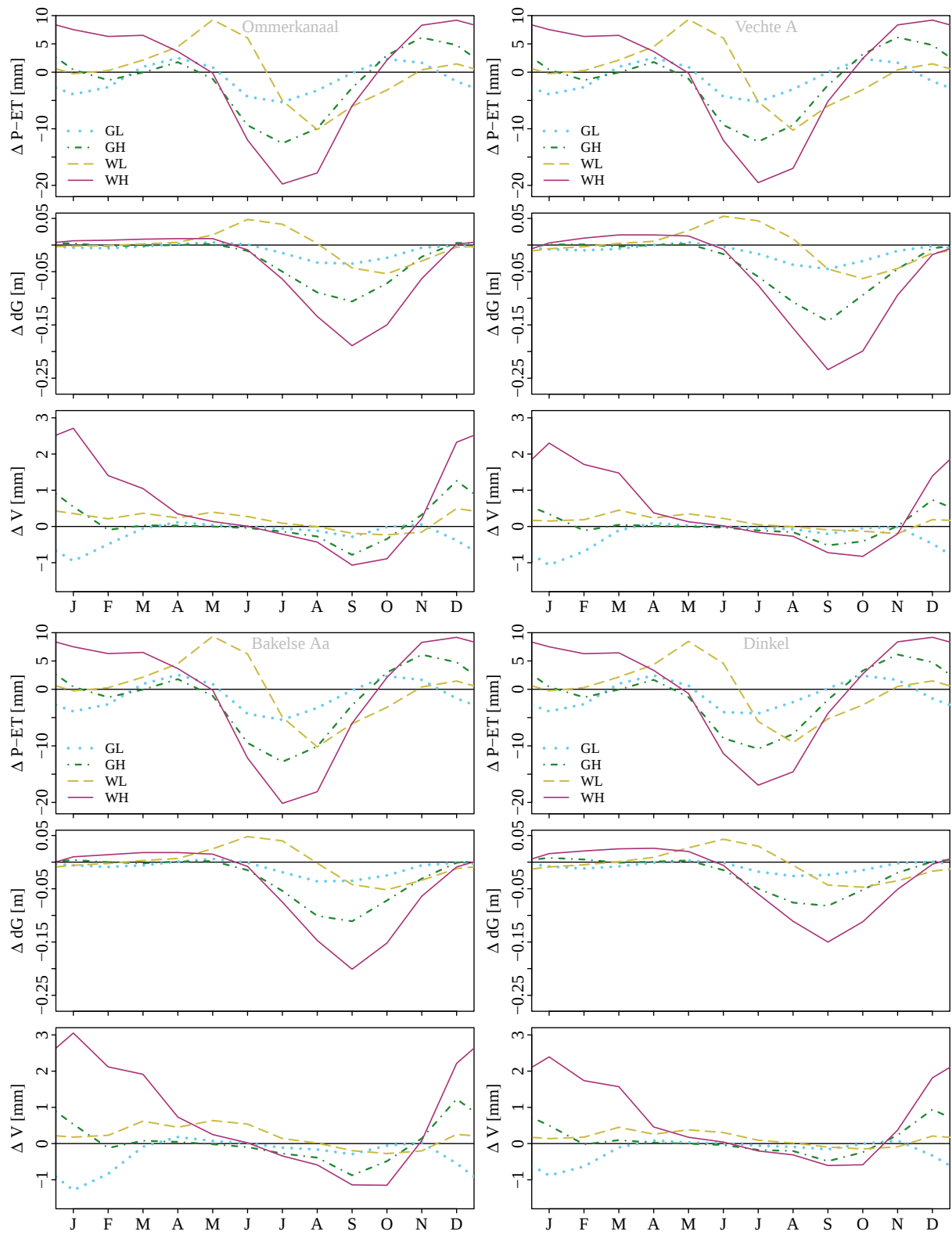


Figure S11. Figure 7 for the Ommerkanaal, Vechte A, Bakelse Aa and Dinkel catchments.

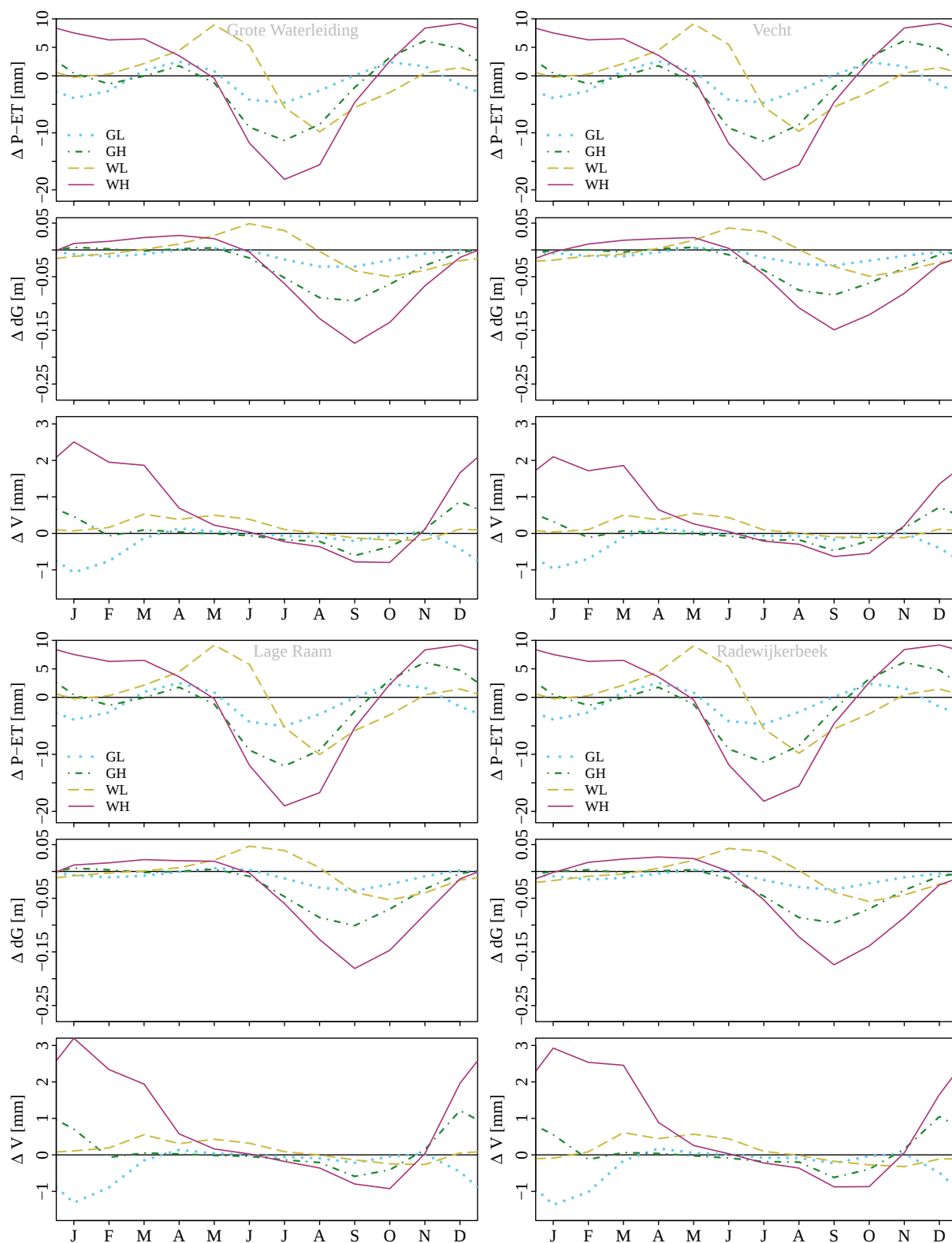


Figure S12. Figure 7 for the Grote Waterleiding, Vecht, Lage Raam and Radewijkerbeek catchments.

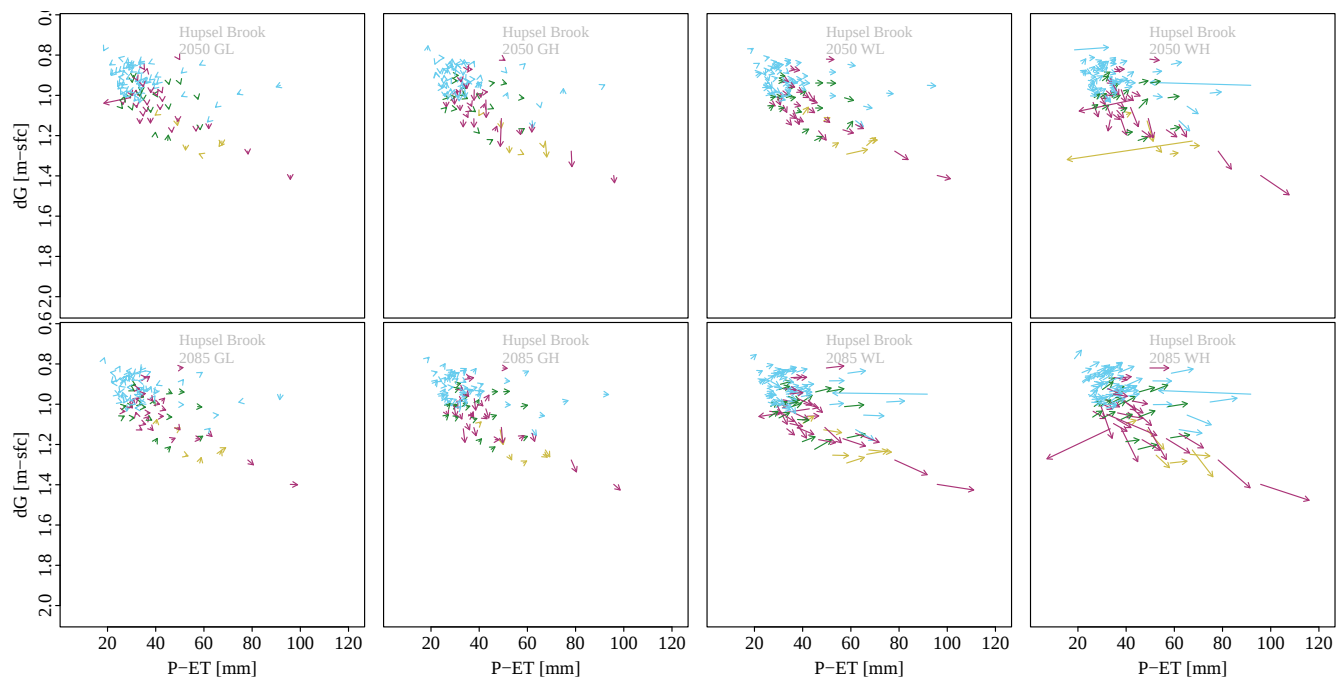


Figure S13. Figure 8a for the Hupsel Brook catchment and all climate scenarios.

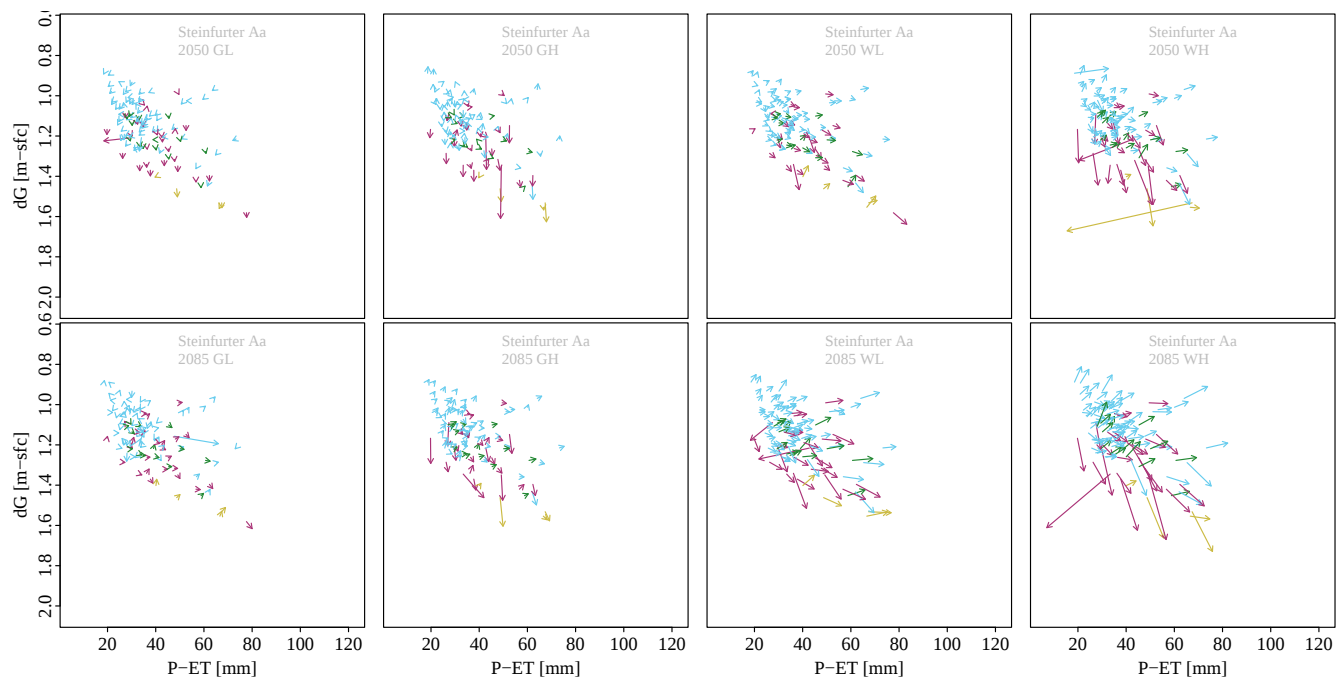


Figure S14. Figure 8a for the Steinfurter Aa catchment and all climate scenarios.

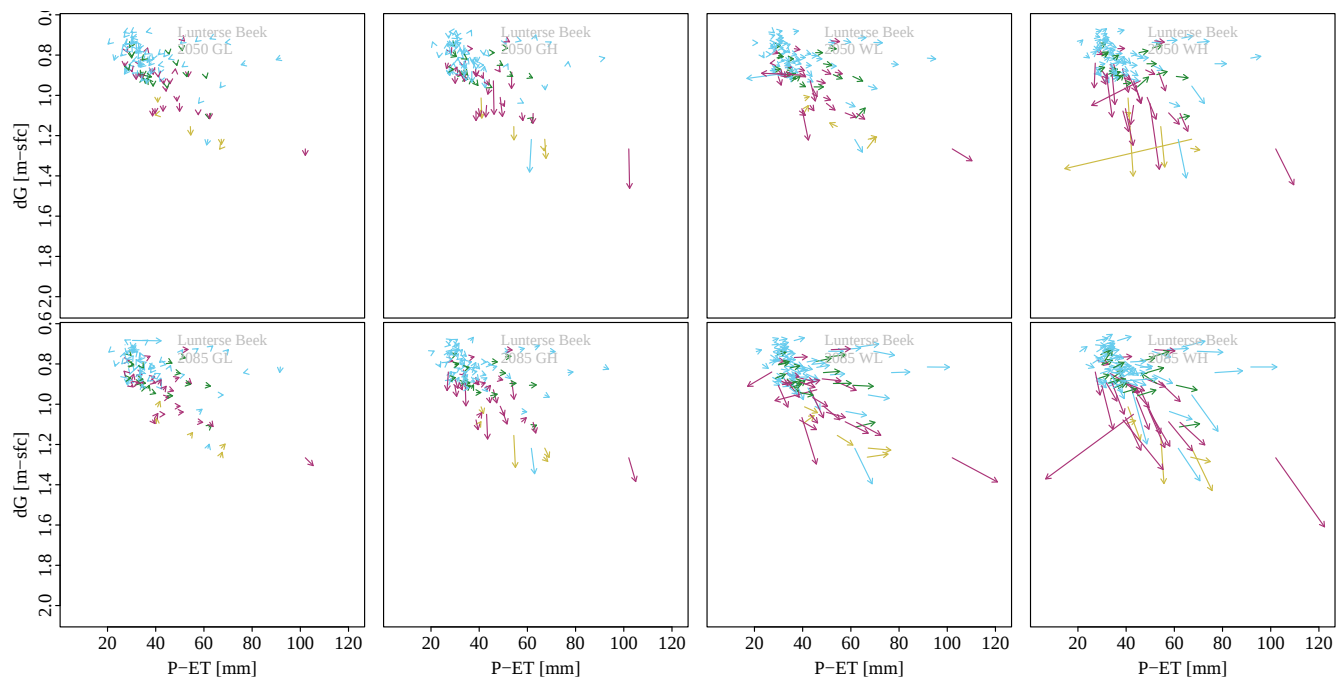


Figure S15. Figure 8a for the Lunterse Beek catchment and all climate scenarios.

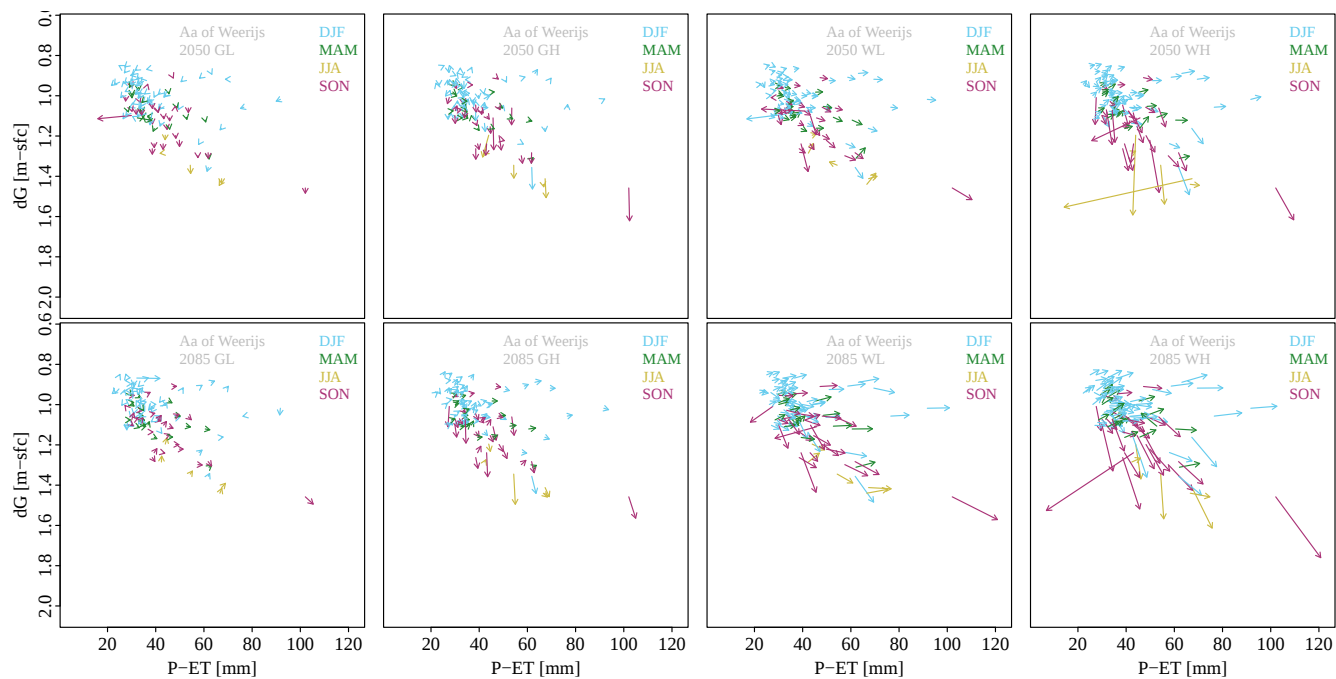


Figure S16. Figure 8a for the Aa of Weerij's catchment and all climate scenarios.

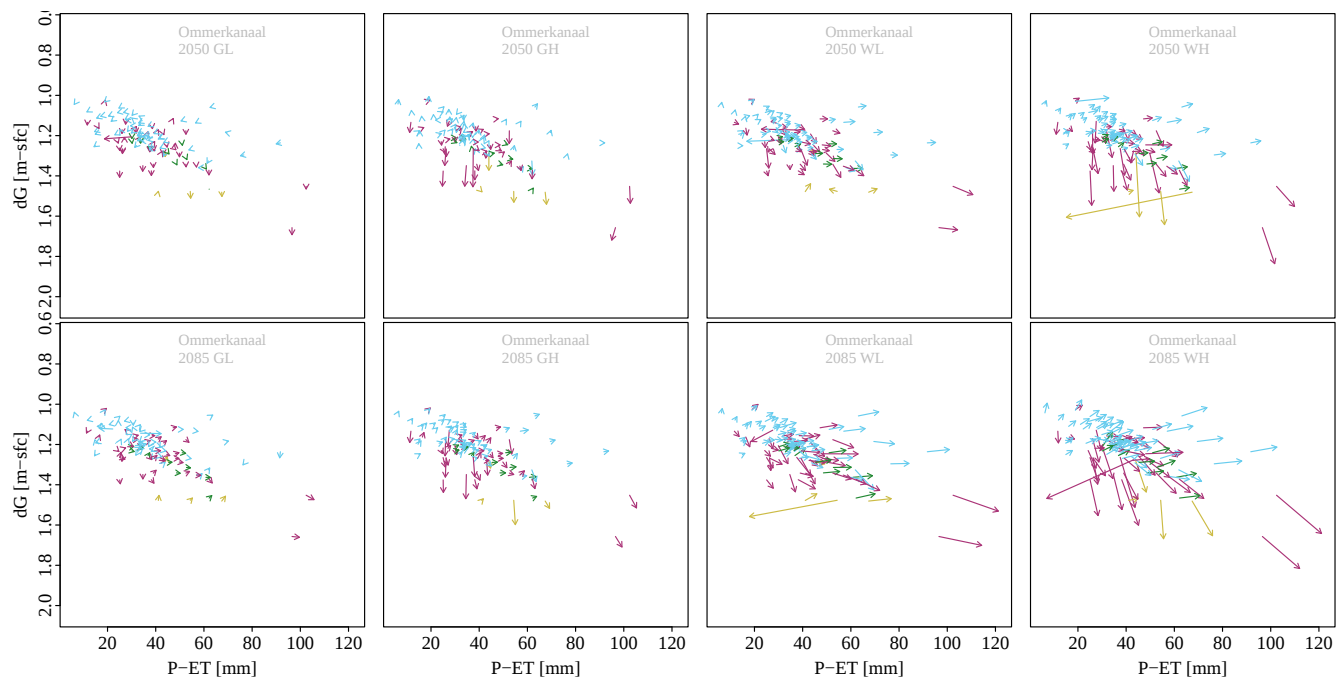


Figure S17. Figure 8a for the Ommerkanaal catchment and all climate scenarios.

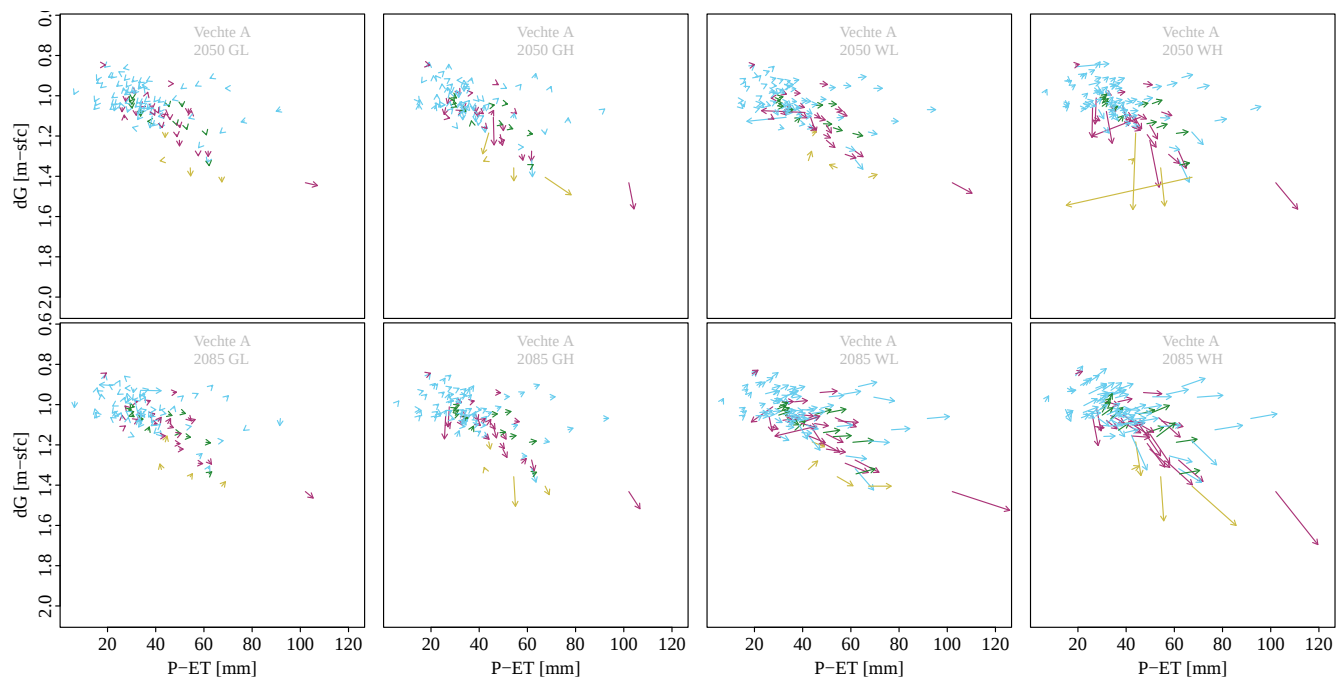


Figure S18. Figure 8a for the Vechte A catchment and all climate scenarios.

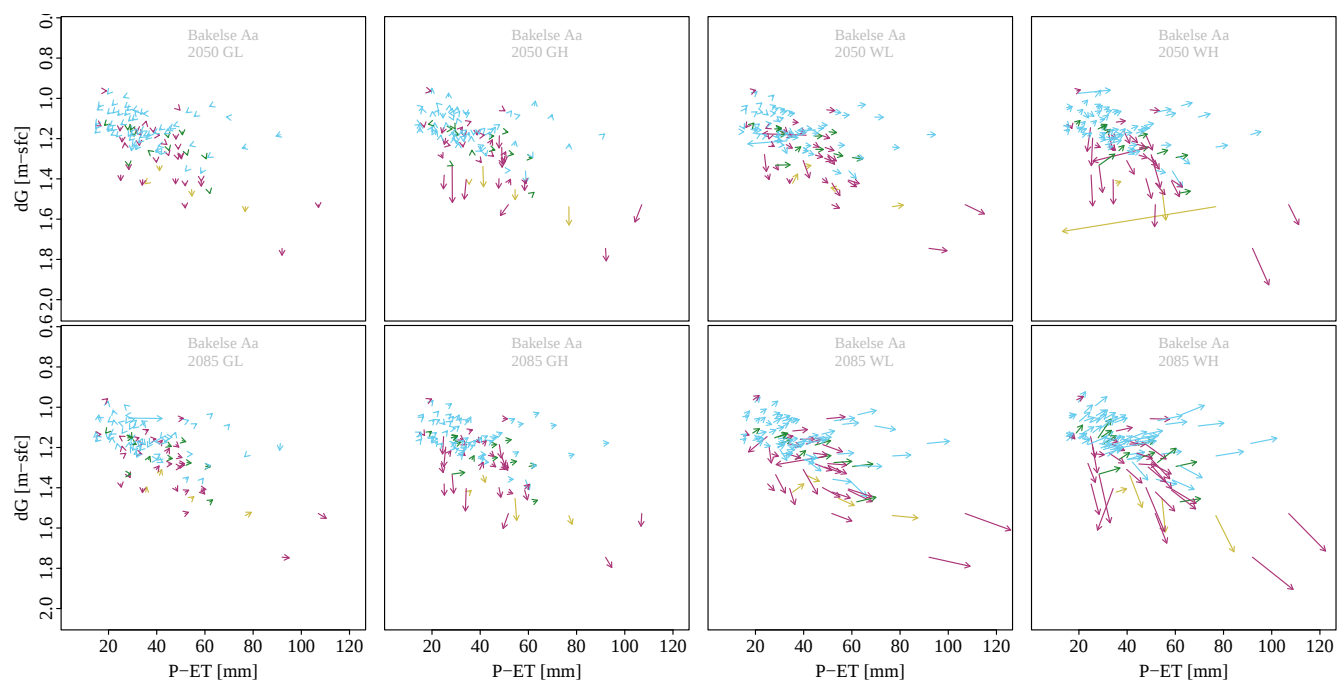


Figure S19. Figure 8a for the Bakelse Aa catchment and all climate scenarios.

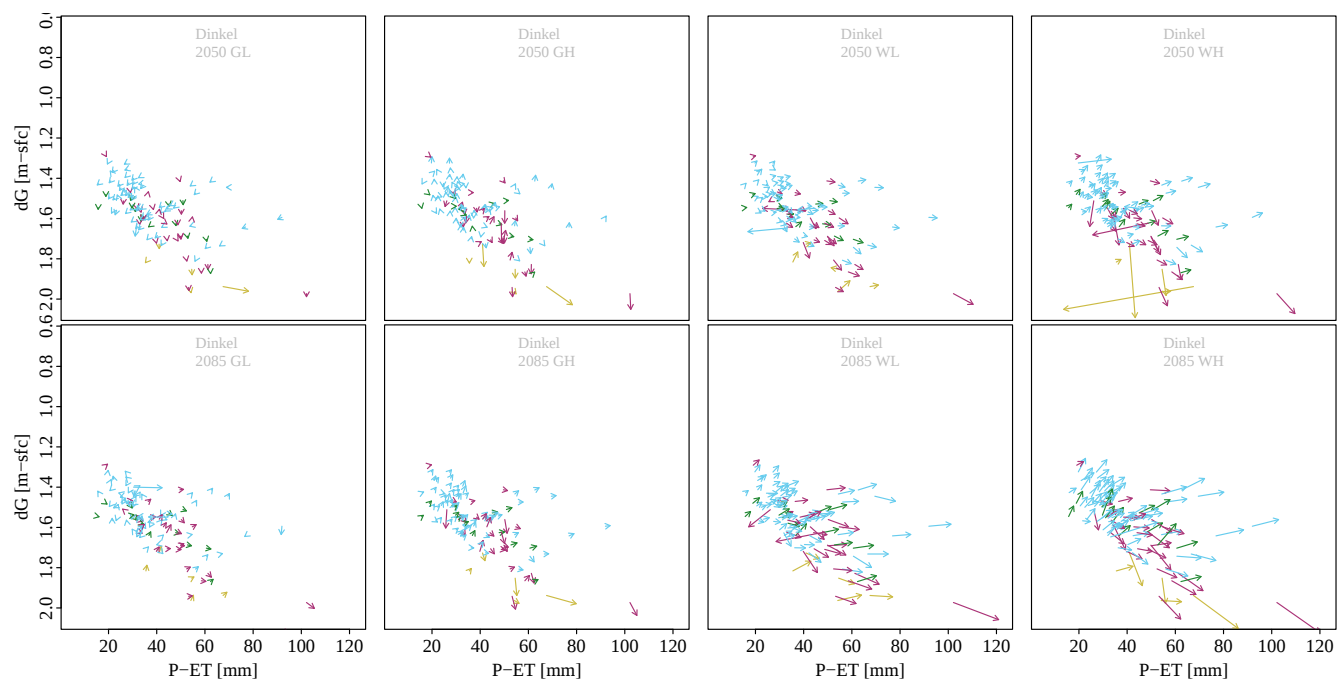


Figure S20. Figure 8a for the Dinkel catchment and all climate scenarios.

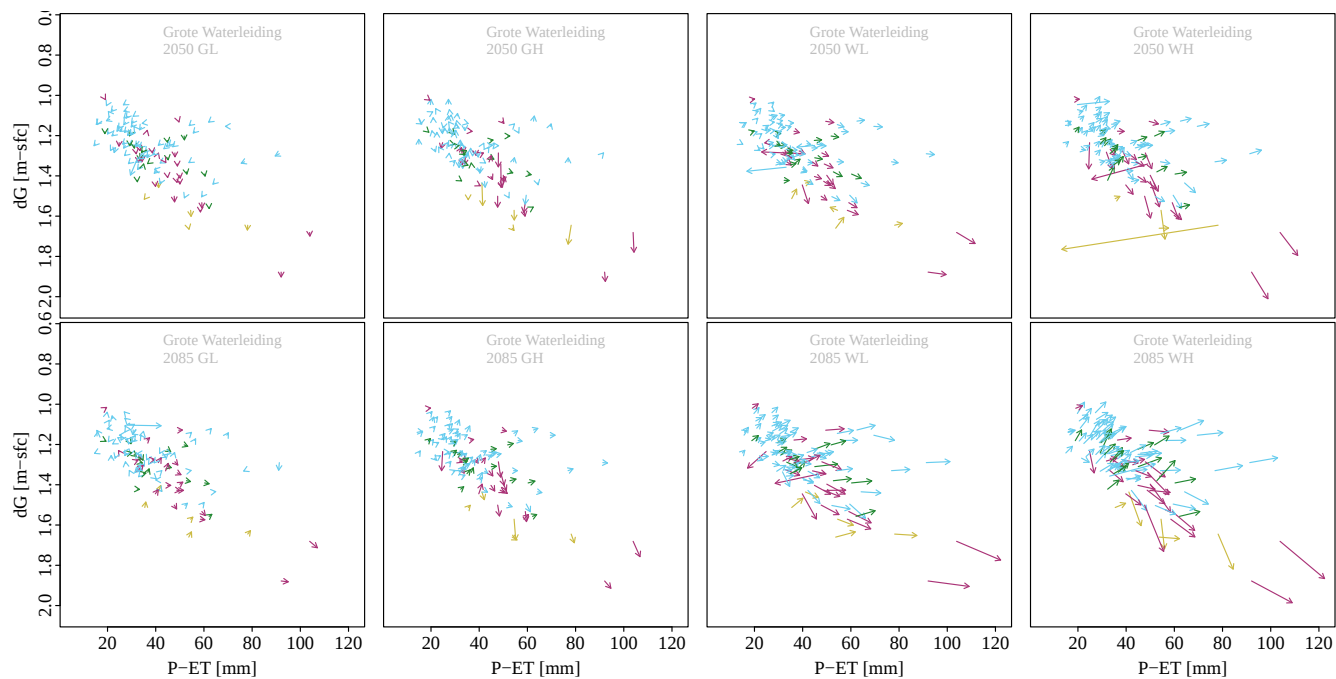


Figure S21. Figure 8a for the Vecht catchment and all climate scenarios.

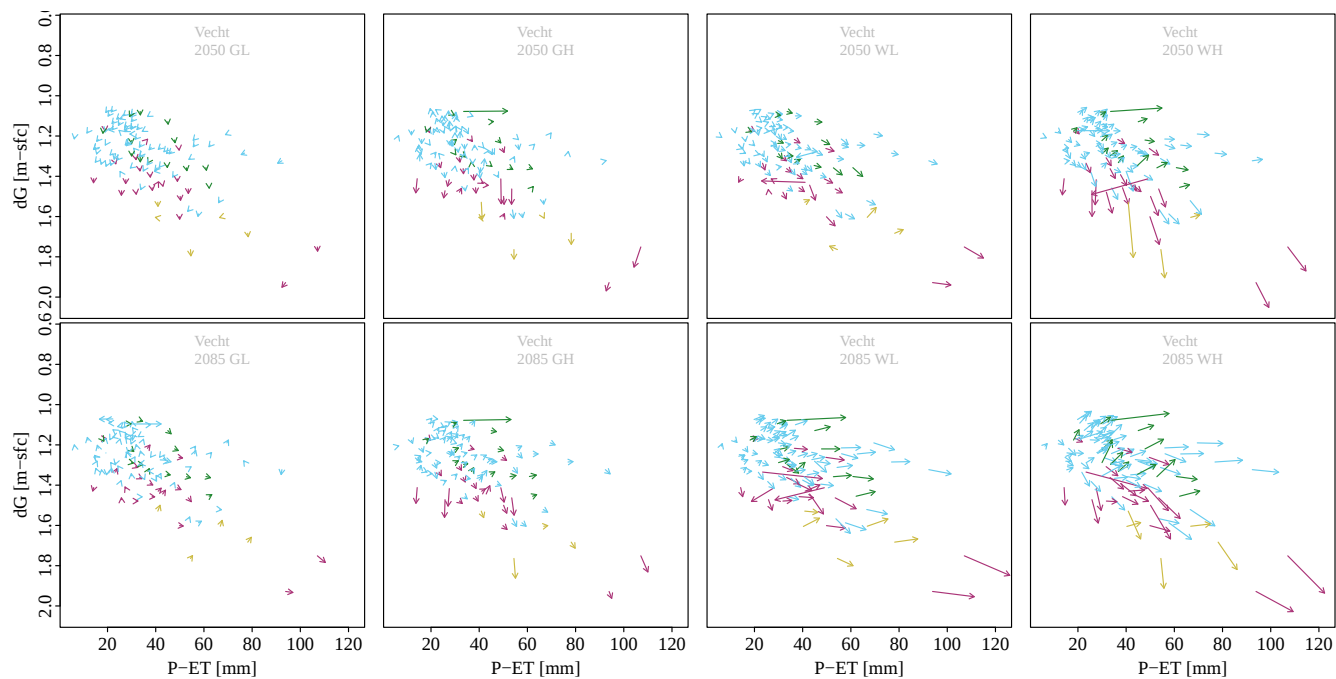


Figure S22. Figure 8a for the Lage Raam catchment and all climate scenarios.

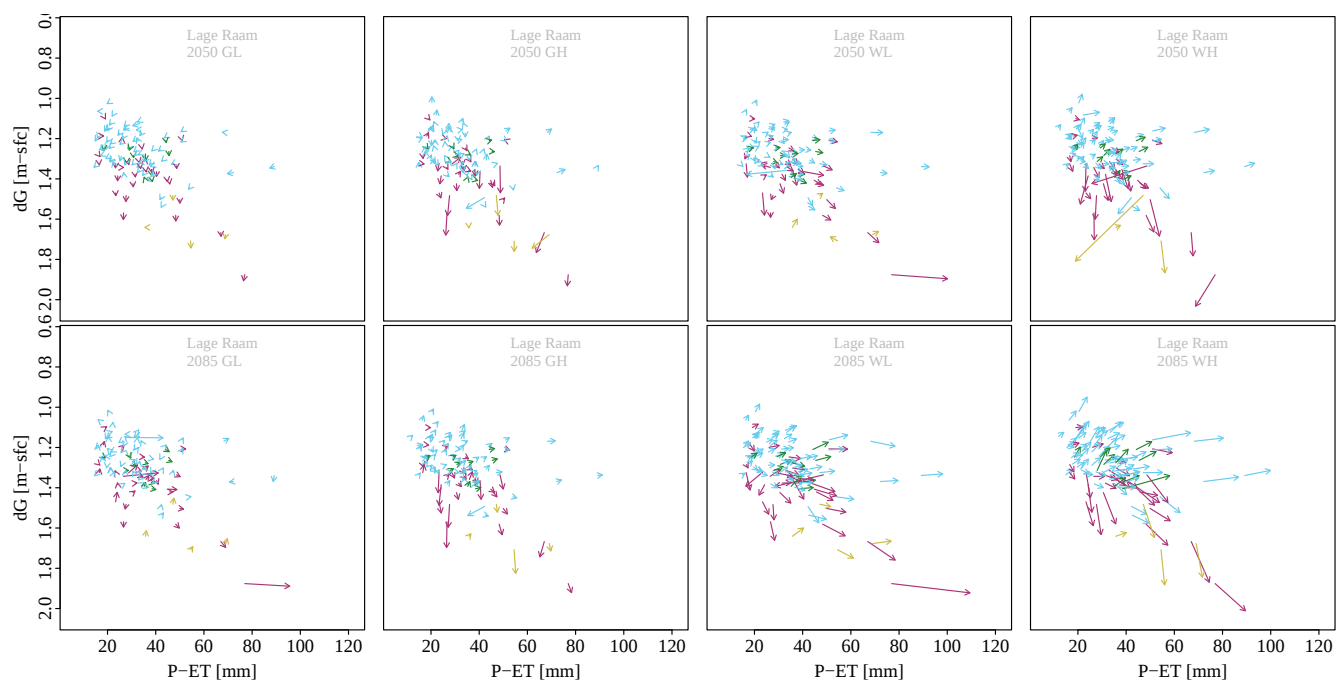


Figure S23. Figure 8a for the Grote Waterleiding catchment and all climate scenarios.

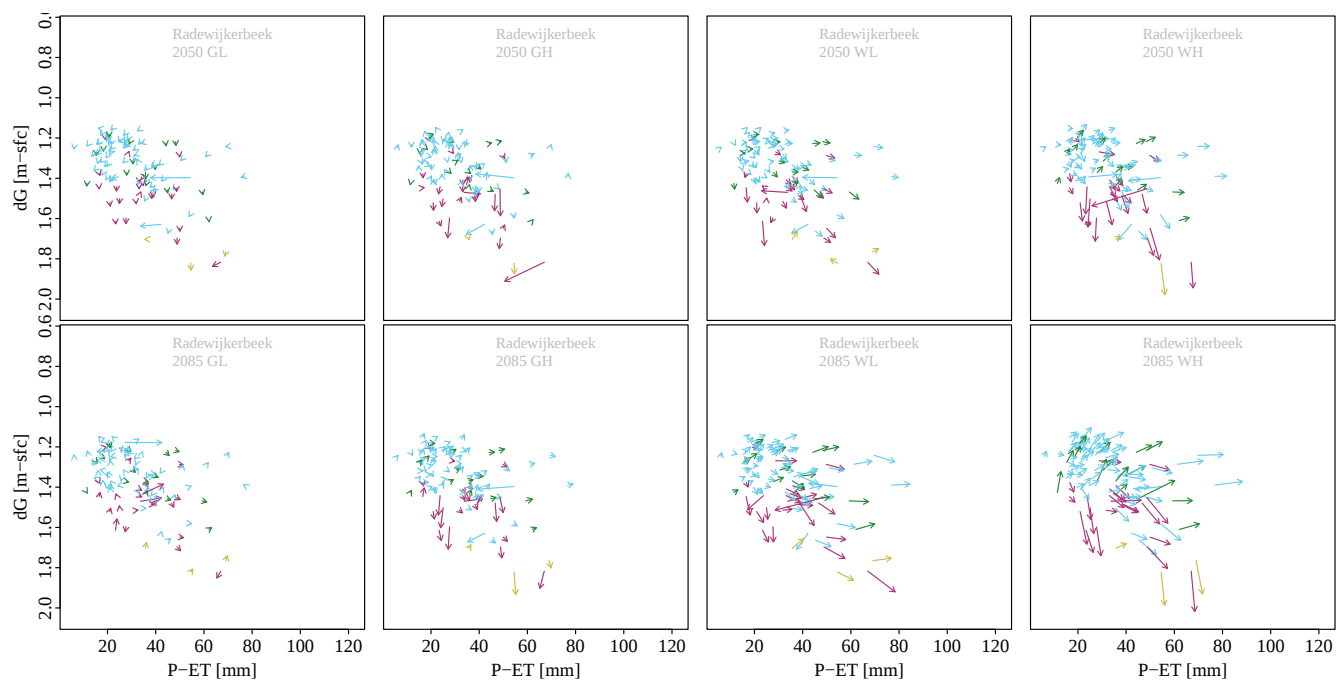


Figure S24. Figure 8a for the Radewijkerbeek catchment and all climate scenarios.

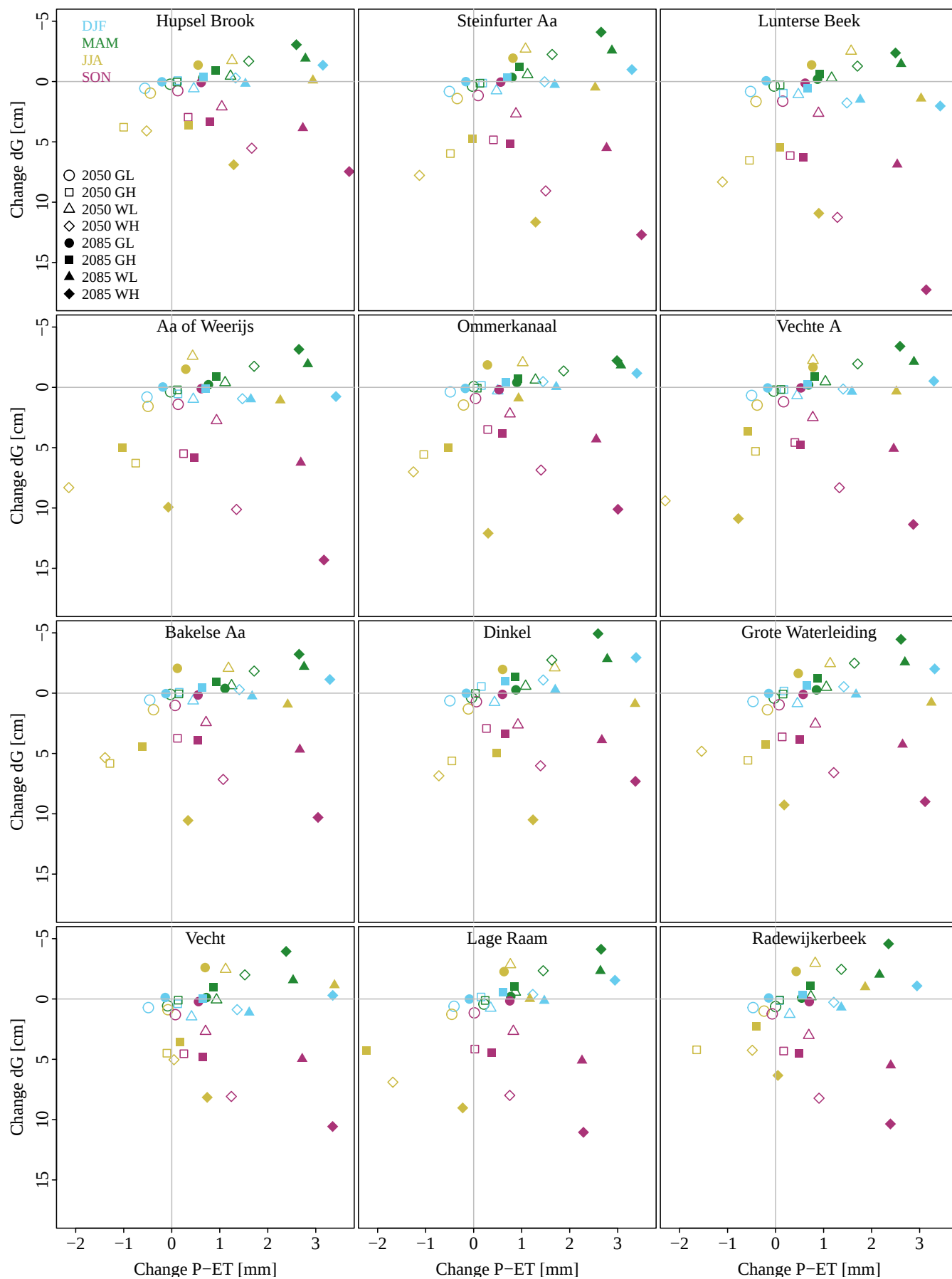


Figure S25. Figure 8b for all catchments.

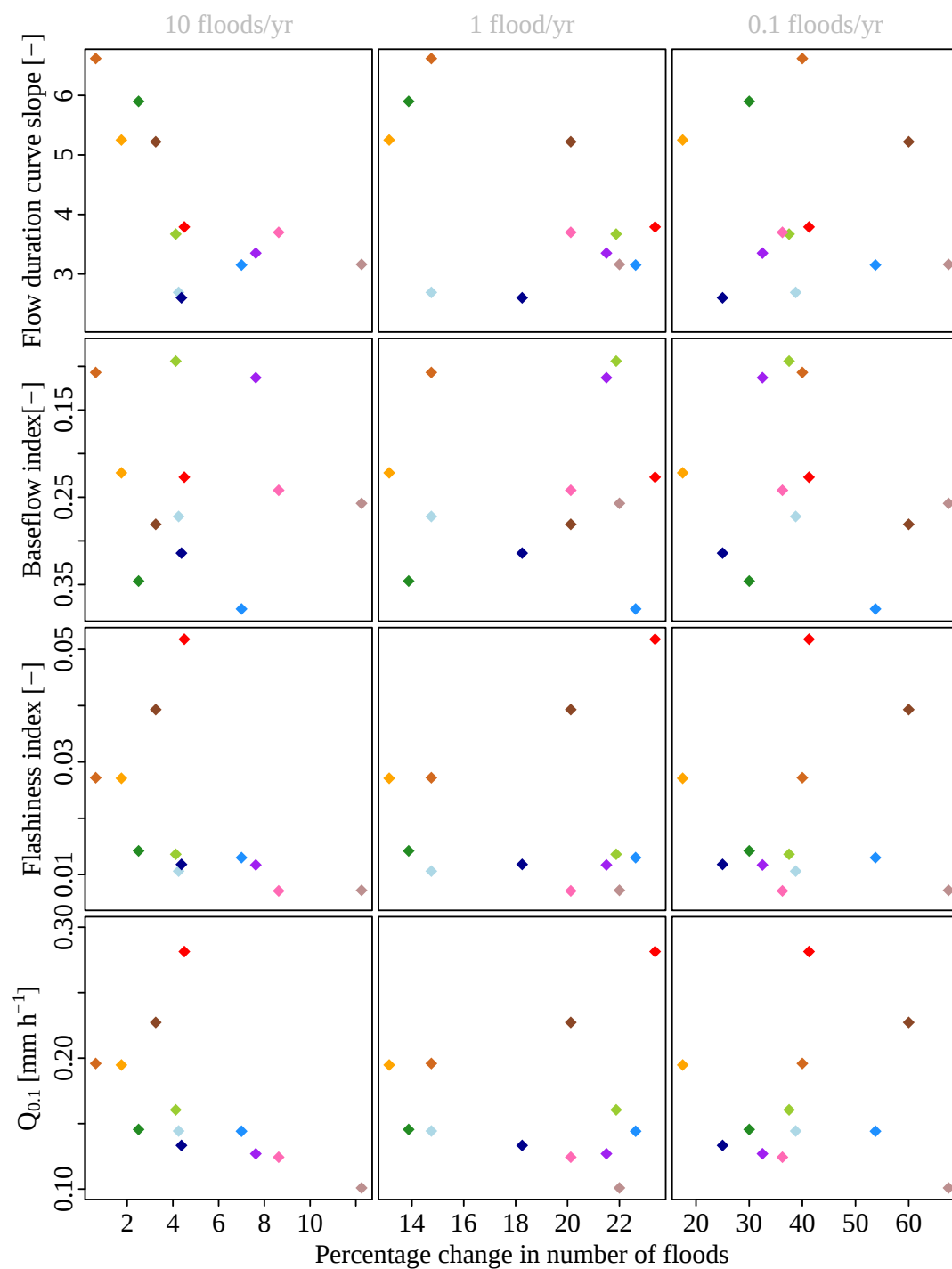


Figure S26. Relation between the percentage change in total number of floods (Fig. 9, top row) and metrics for discharge dynamics (Fig. 3), averaged over all climate scenarios. Colors are the same for each catchment (same as in Figs. 3 and 6).

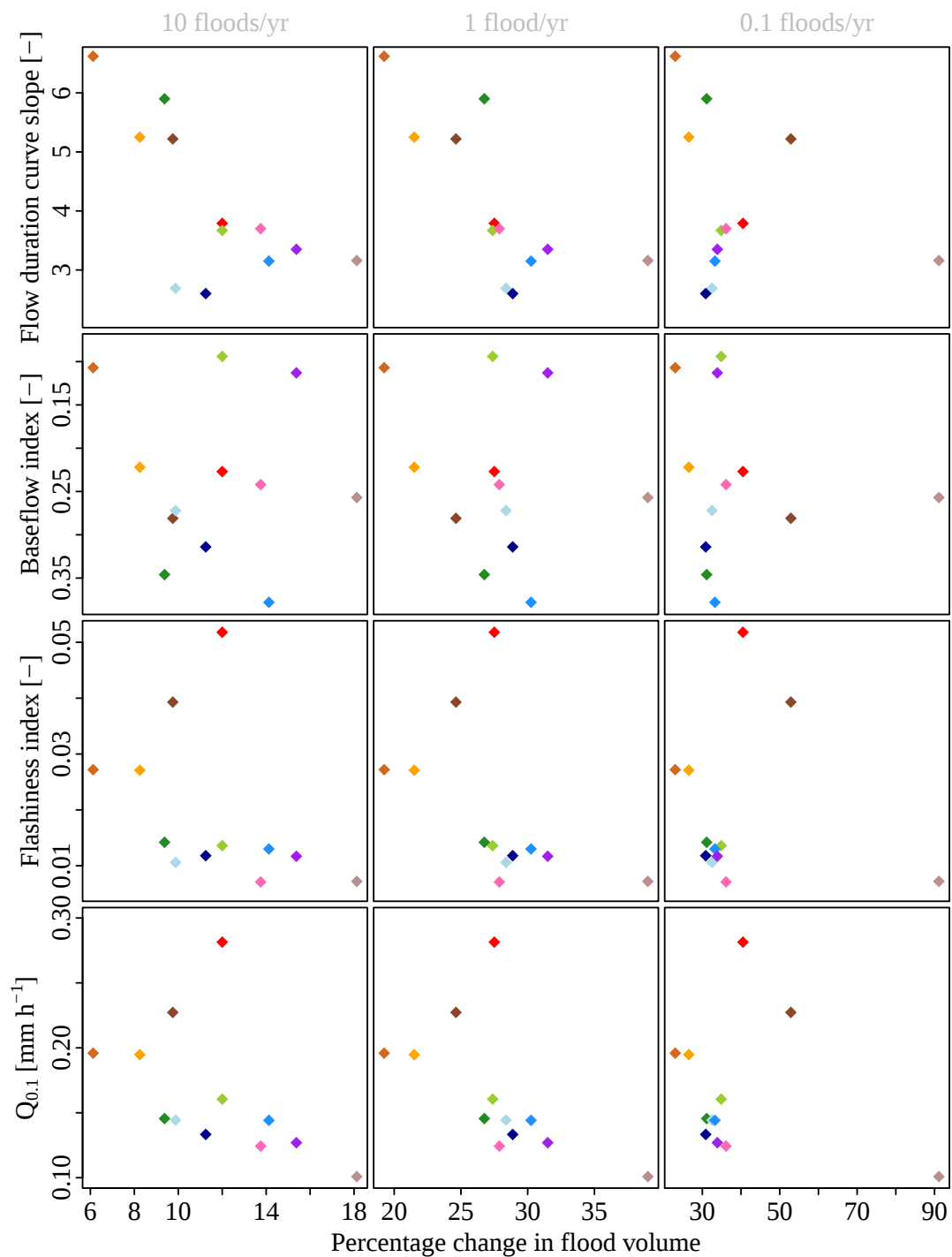


Figure S27. Relation between the percentage change in total flood volume (Fig. 9, bottom row) and metrics for discharge dynamics (Fig. 3), averaged over all climate scenarios. Colors are the same for each catchment (same as in Figs. 3 and 6).

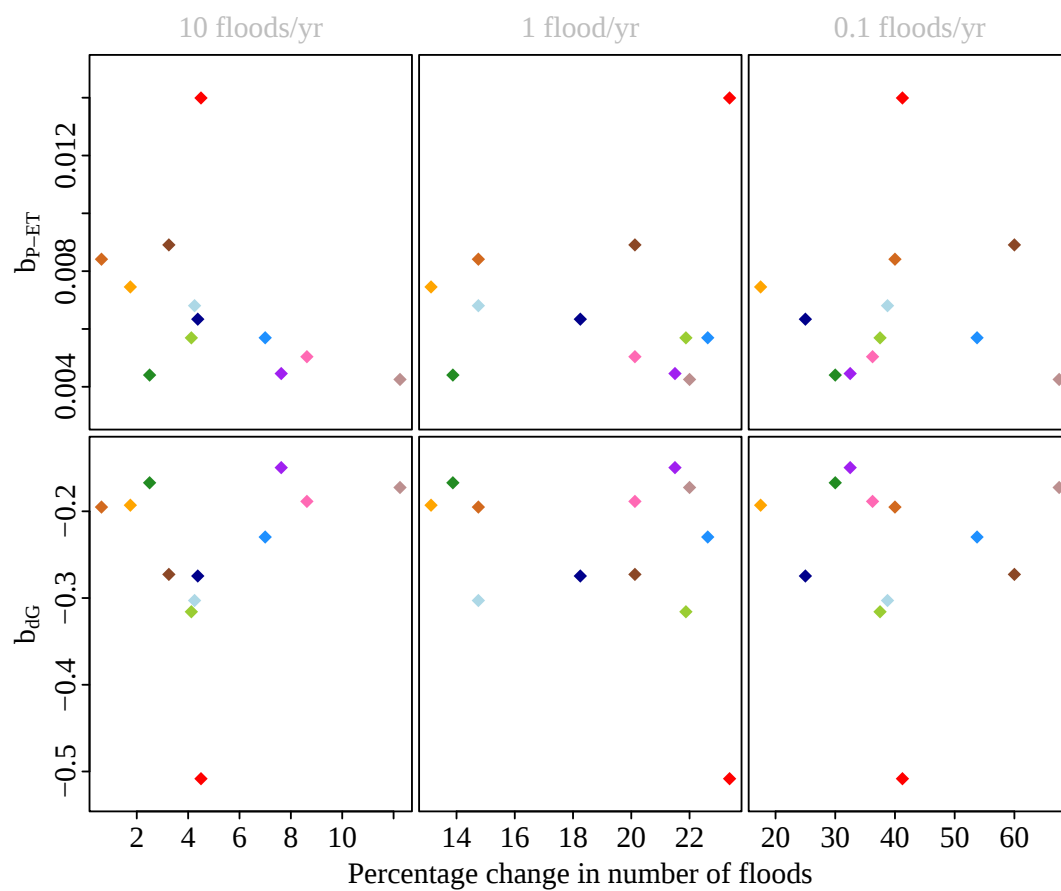


Figure S28. Relation between the percentage change in total number of floods (Fig. 9, top row) and regression parameters (Fig. 6), averaged over all climate scenarios. Colors are the same for each catchment (same as in Figs. 3 and 6).

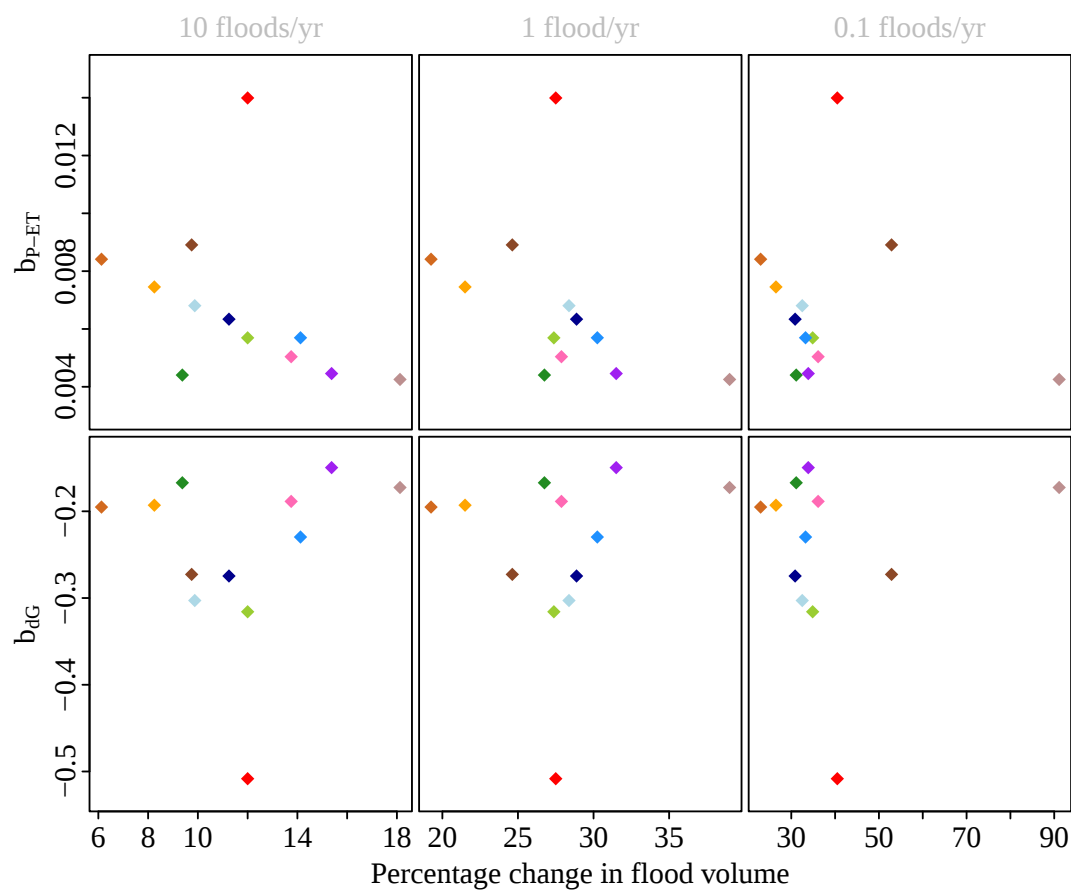


Figure S29. Relation between the percentage change in total flood volume (Fig. 9, bottom row) and regression parameters (Fig. 6), averaged over all climate scenarios. Colors are the same for each catchment (same as in Figs. 3 and 6).

References

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