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Supplementary material for: The influence of climate change on flood risks in France — first estimates and uncertainty analysis

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1 Validation

Figures 1 to 4 show the comparison of return levels between observations, SFS and QMS or WTS. They are referred to in section 3.1.

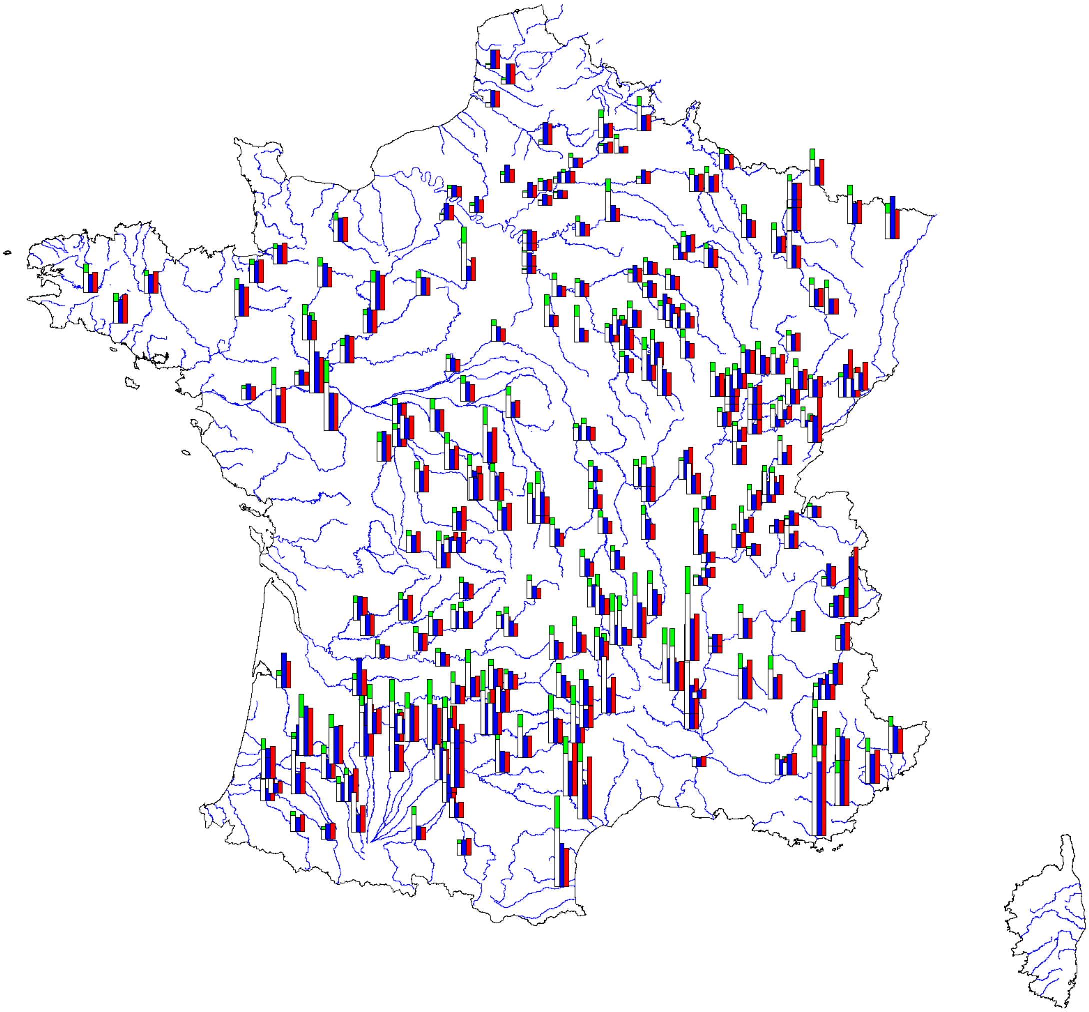

Fig. 1. Comparison of the return level associated with a 10-year event for SFS and QMS with the 95% confidence interval of observations obtained with a Gumbel. The confidence interval for observations is in green, the return level for SFS is in red and the return level for QMS is in blue. return levels are divided by the mean observations streamflow.

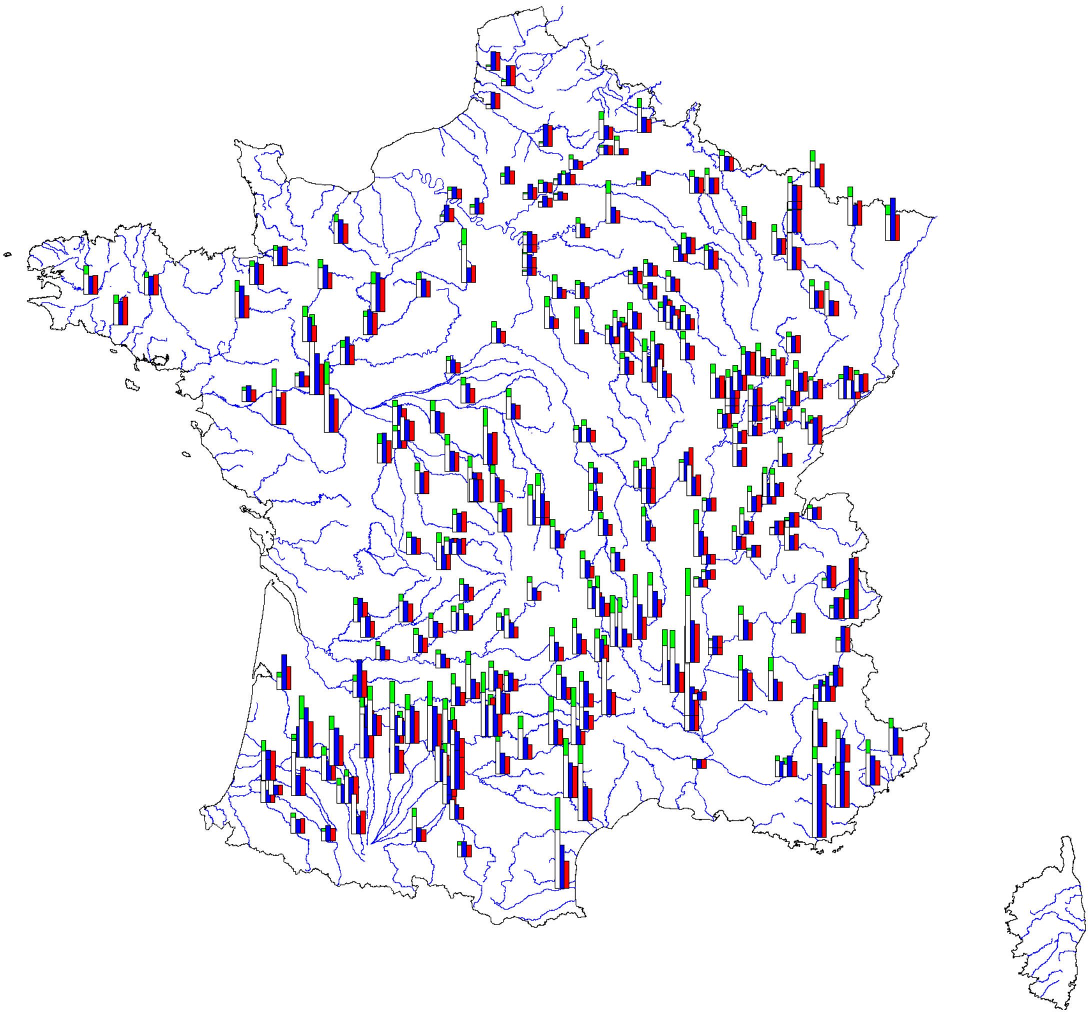

Fig. 2. Comparison of the return level associated with a 10-year event for SFS and WTS with the 95% confidence interval of observations obtained with a Gumbel. The confidence interval for observations is in green, the return level for SFS is in red and the return level for WTS is in blue. return levels are divided by the mean observations streamflow.

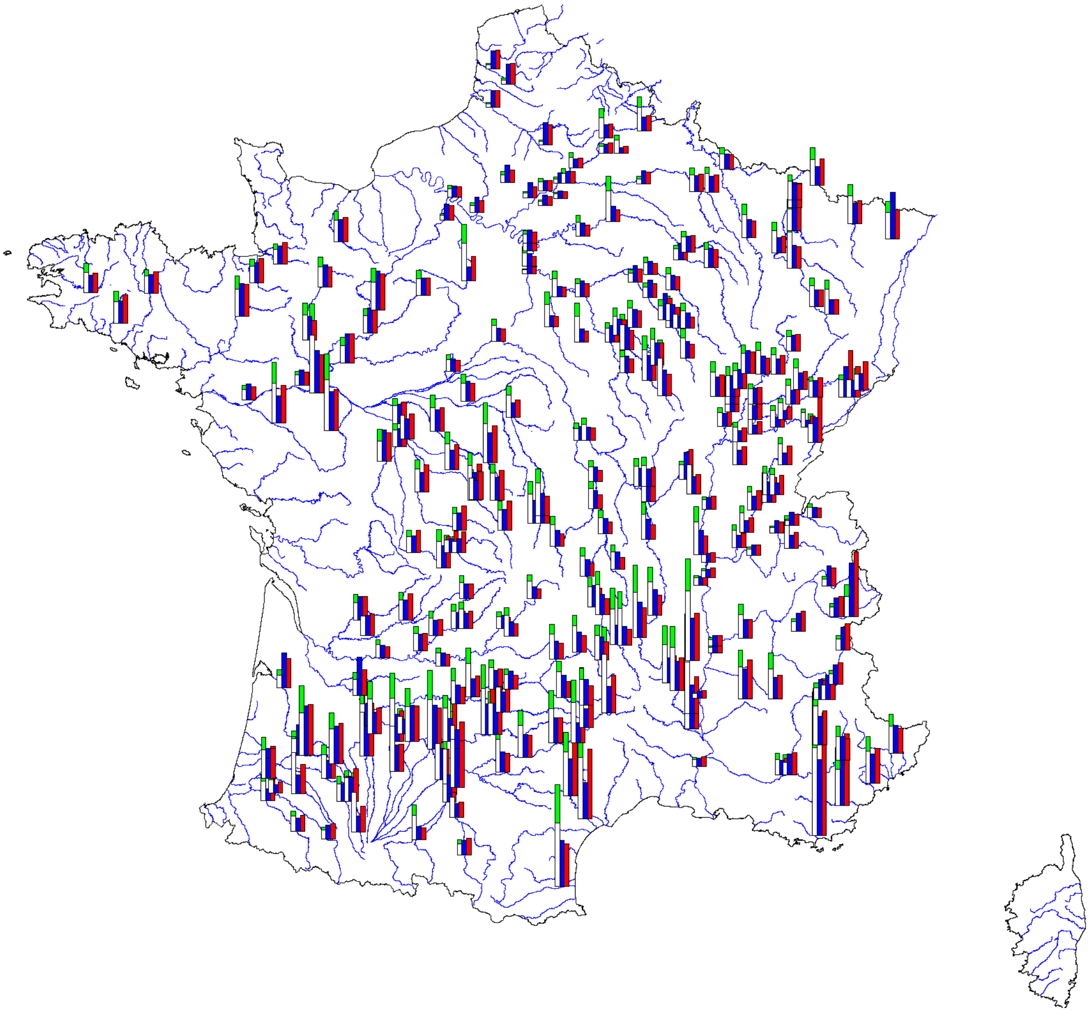

Fig. 3. Comparison of the return level associated with a 100-year event for SFS and QMS with the 95% confidence interval of observations obtained with a Gumbel. The confidence interval for observations is in green, the return level for SFS is in red and the return level for QMS is in blue. return levels are divided by the mean observations streamflow.

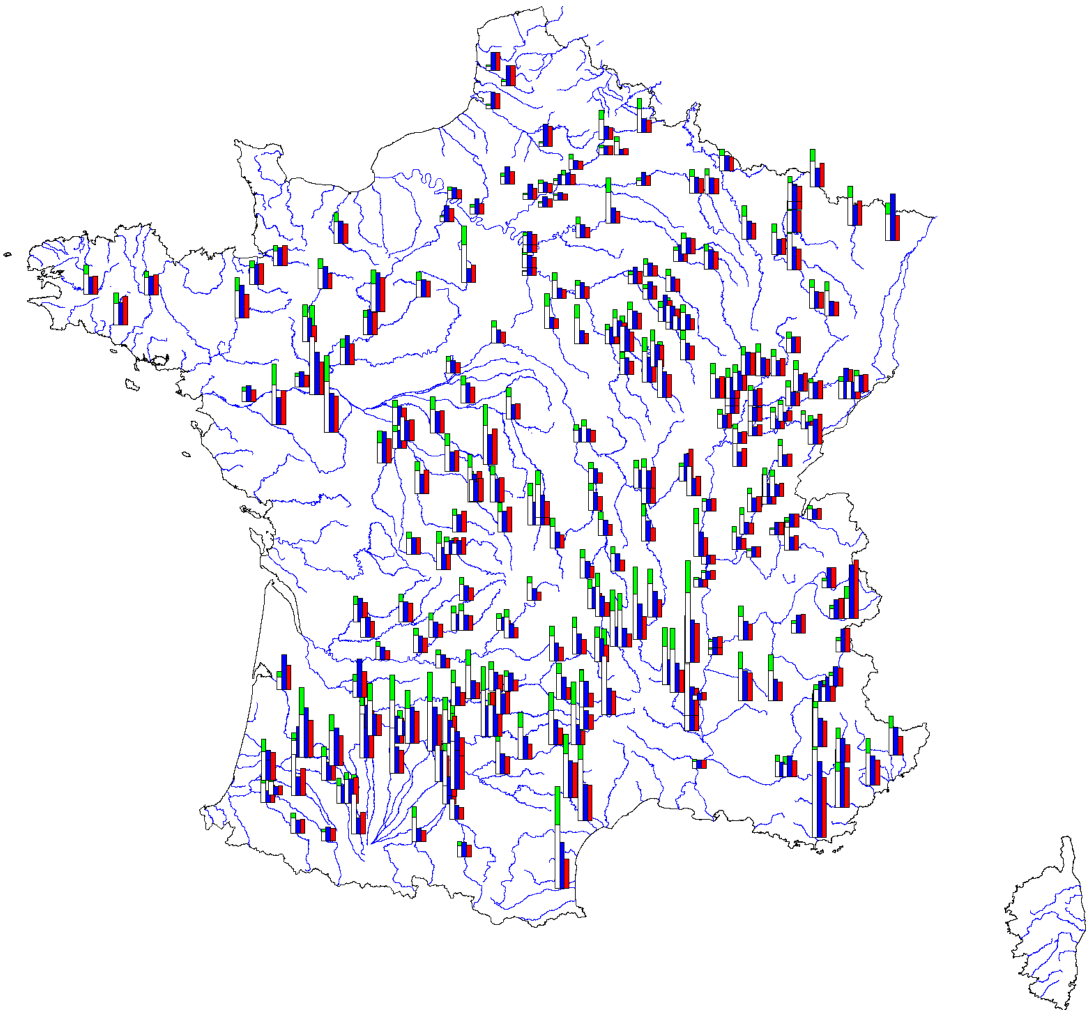

Fig. 4. Comparison of the return level associated with a 100-year event for SFS and WTS with the 95% confidence interval of observations obtained with a Gumbel. The confidence interval for observations is in green, the return level for SFS is in red and the return level for WTS is in blue. return levels are divided by the mean observations streamflow.

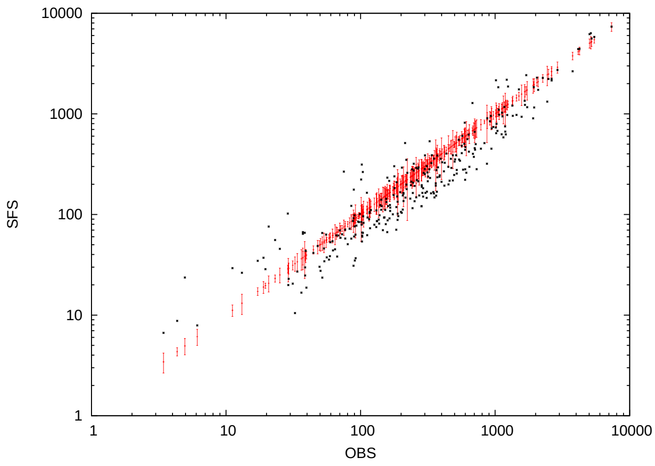

Fig. 5. Return level of SFS against observations OBS, for a ten year return level on a log-log scale. The error bars correspond to the 95% confidence interval for the observations.

2 Validation of GEV statistics

Table 1 shows comparisons of return levels for the GEV statistic.

Figure 5 and figure 6 shows the dispersion of the return levels outside of the 95% confidence interval.

Figures 7 to 10 show the comparison of return levels between observations, SFS and QMS or WTS for a GEV.

Table 1. Number of stations with a return level below (<), in the 95% confidence interval (in), or above (>), for different return periods and different simulations compared to references (OBS is the reference for SFS, SFS is the reference for QMS and WTS).

Return periods	10 years			50 years			100 years		
	<	in	>	<	in	>	<	in	>
SFS vs OBS	60.2	23.3	16.5	51.9	35.7	12.4	45.5	43.2	11.3
QMS vs SFS	24.2	40.6	35.2	12.5	46.5	41.0	8.9	49.9	41.2
WTS vs SFS	43.0	40.0	17.0	9.0	50.7	40.2	3.7	51.5	44.8

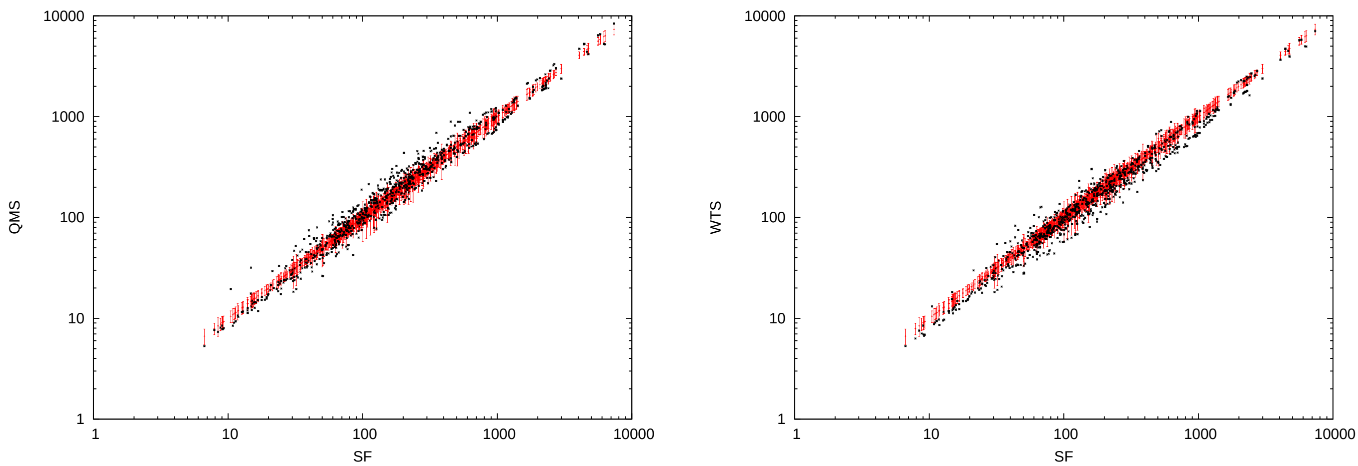

Fig. 6. Return levels of QMS and WTS against SFS, for a ten year return level on a log-log scale. The error bars correspond to the 95% confidence interval for the SFS return levels.

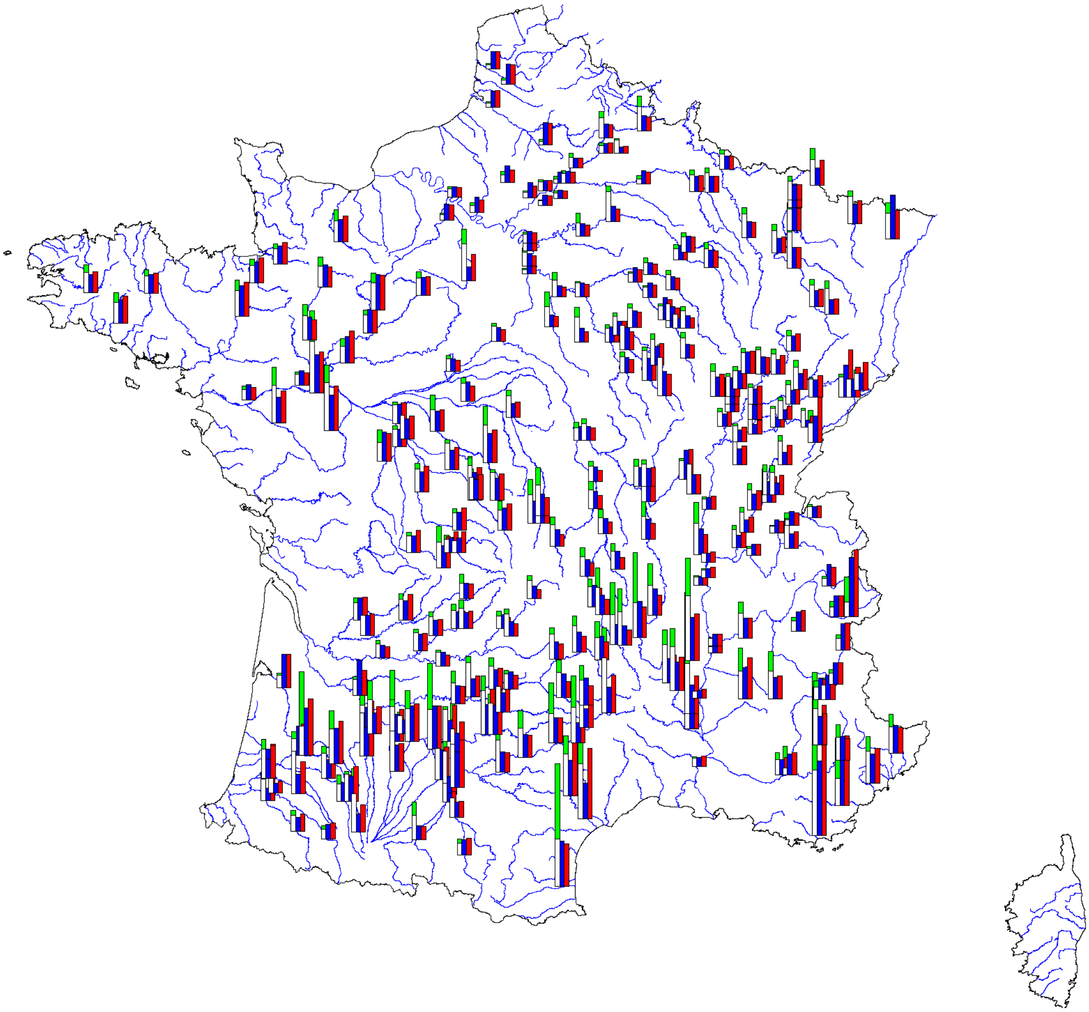

Fig. 7. Comparison of the return level associated with a 10-year event for SFS and QMS with the 95% confidence interval of observations obtained with a GEV. The confidence interval for observations is in green, the return level for SFS is in red and the return level for QMS is in blue. return levels are divided by the mean observations streamflow.

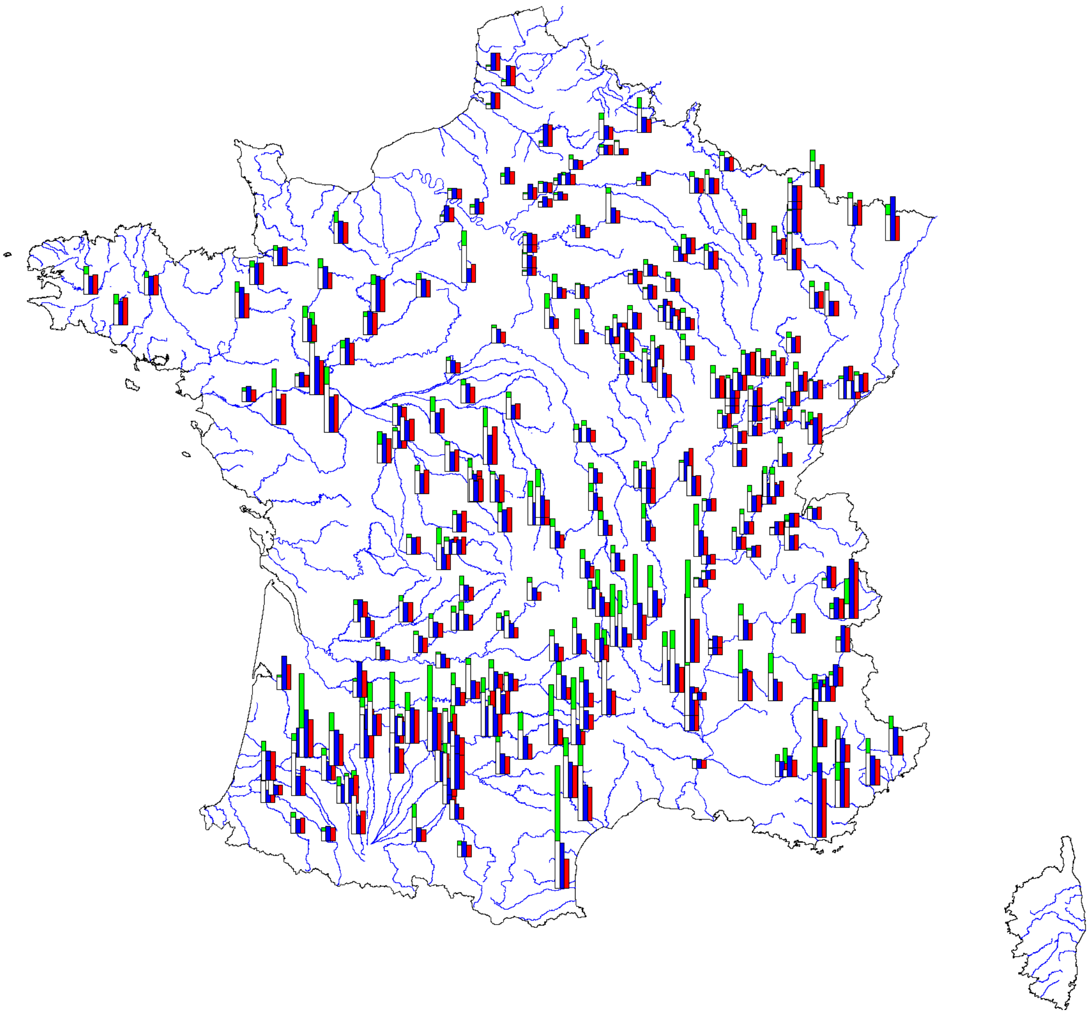

Fig. 8. Comparison of the return level associated with a 10-year event for SFS and WTS with the 95% confidence interval of observations obtained with a GEV. The confidence interval for observations is in green, the return level for SFS is in red and the return level for WTS is in blue. return levels are divided by the mean observations streamflow.

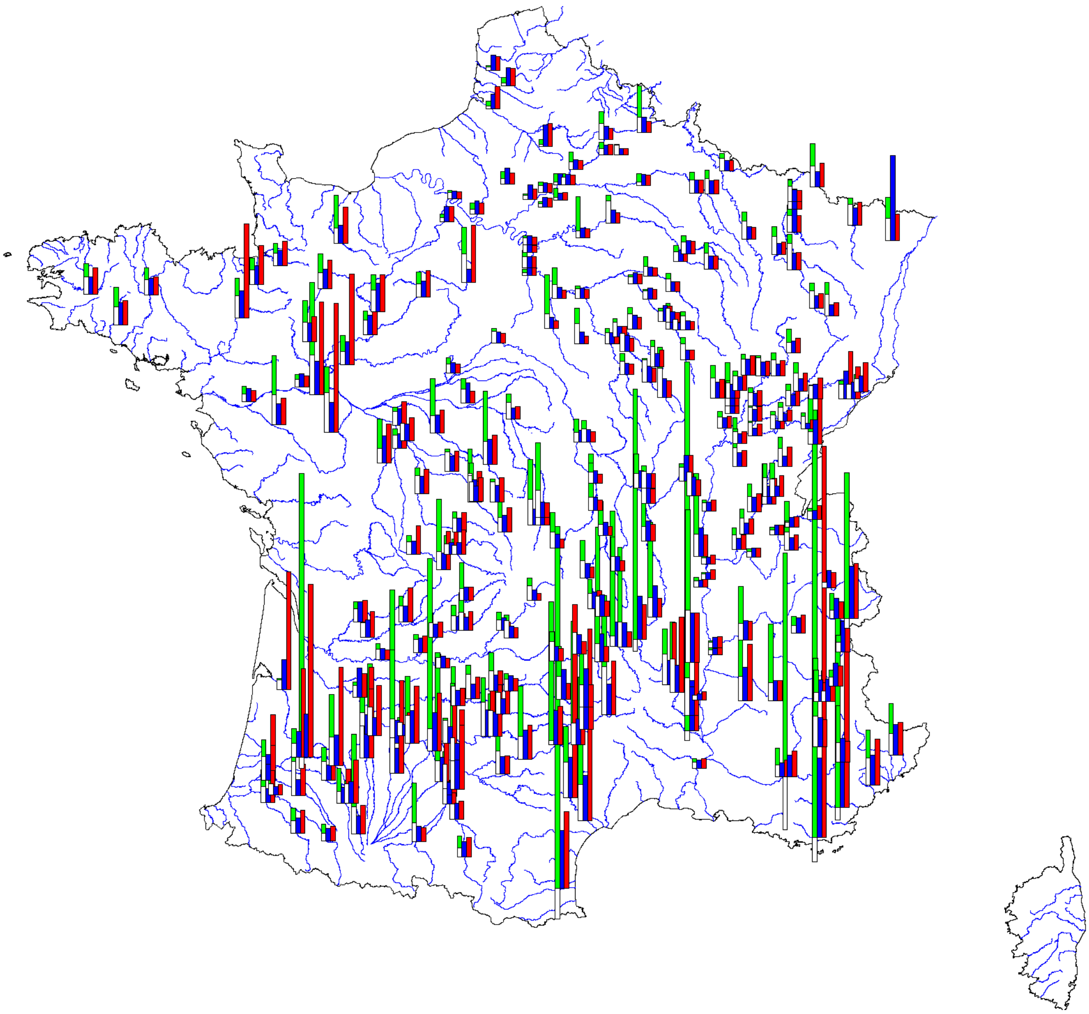

Fig. 9. Comparison of the return level associated with a 100-year event for SFS and QMS with the 95% confidence interval of observations obtained with a GEV. The confidence interval for observations is in green, the return level for SFS is in red and the return level for QMS is in blue. return levels are divided by the mean observations streamflow.

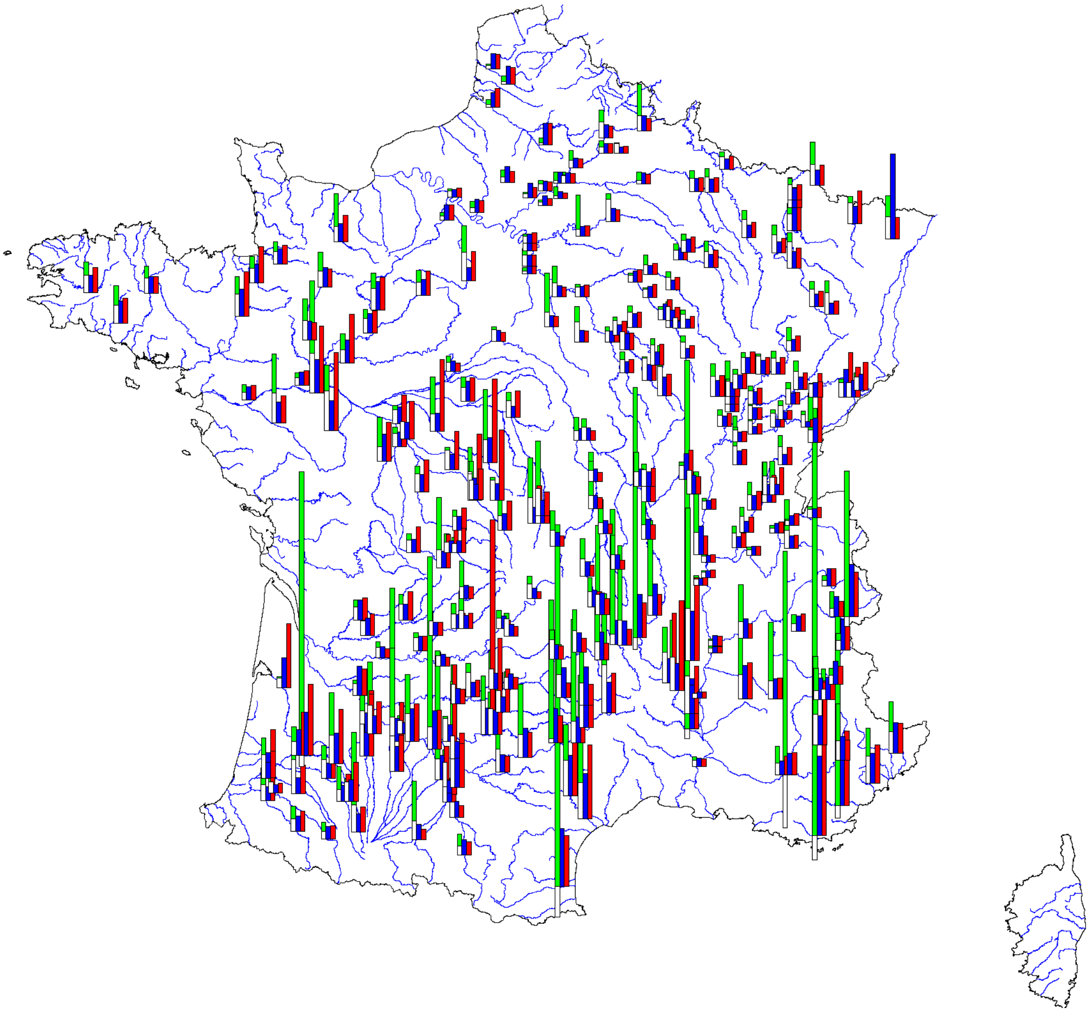

Fig. 10. Comparison of the return level associated with a 100-year event for SFS and WTS with the 95% confidence interval of observations obtained with a GEV. The confidence interval for observations is in green, the return level for SFS is in red and the return level for WTS is in blue. return levels are divided by the mean observations streamflow.

3 Return period changes with a Gumbel

Figures 11 to 17 show the return period under climate change corresponding to a present year reference return level. They are referred to in section 3.2.

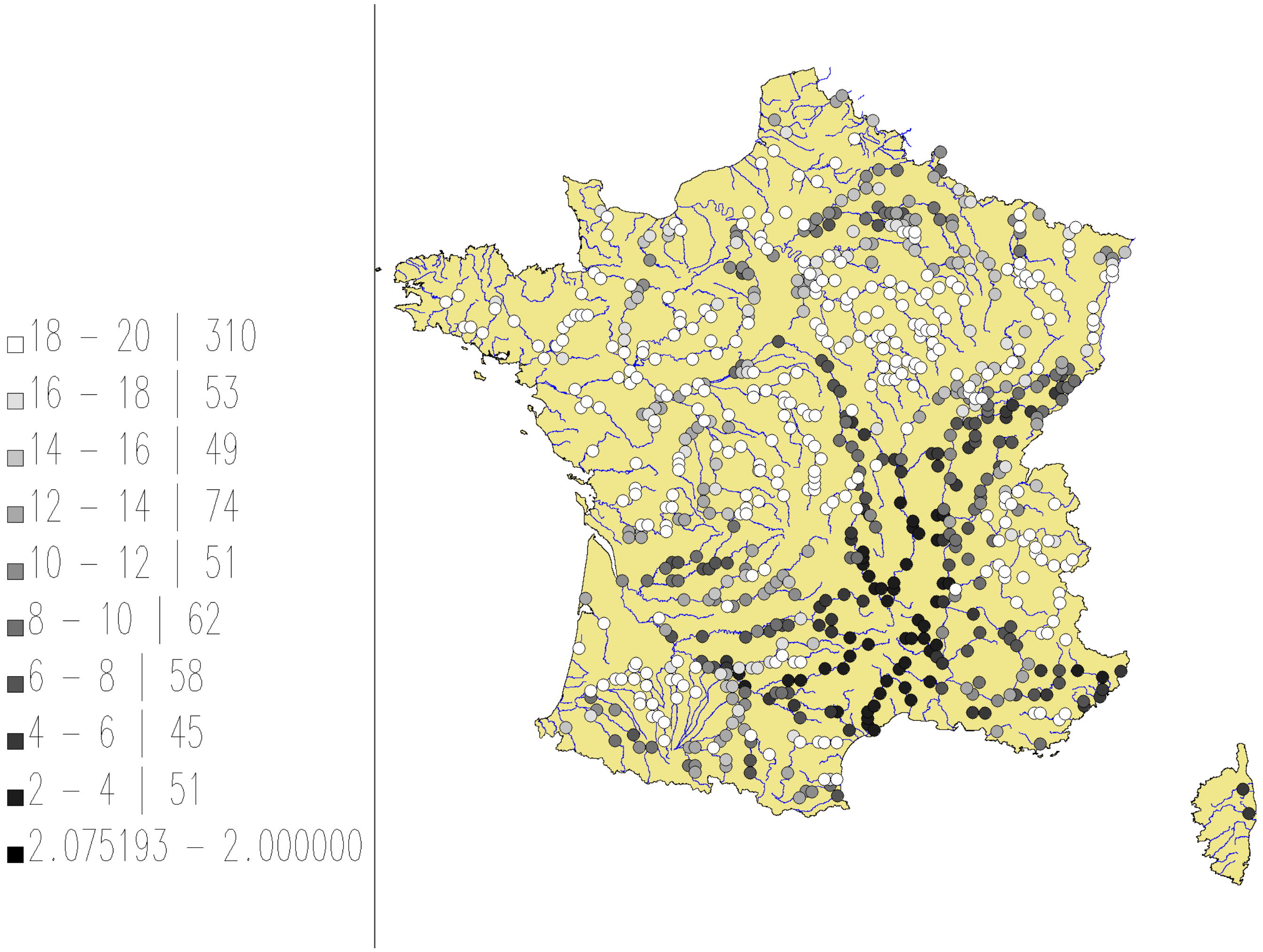

Fig. 11. Return period under climate change associated with the present time 10 years return period level. A Gumbel distribution is used for the statistical analysis, the downscaling technique is WT and the future time period is 2035-2064. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

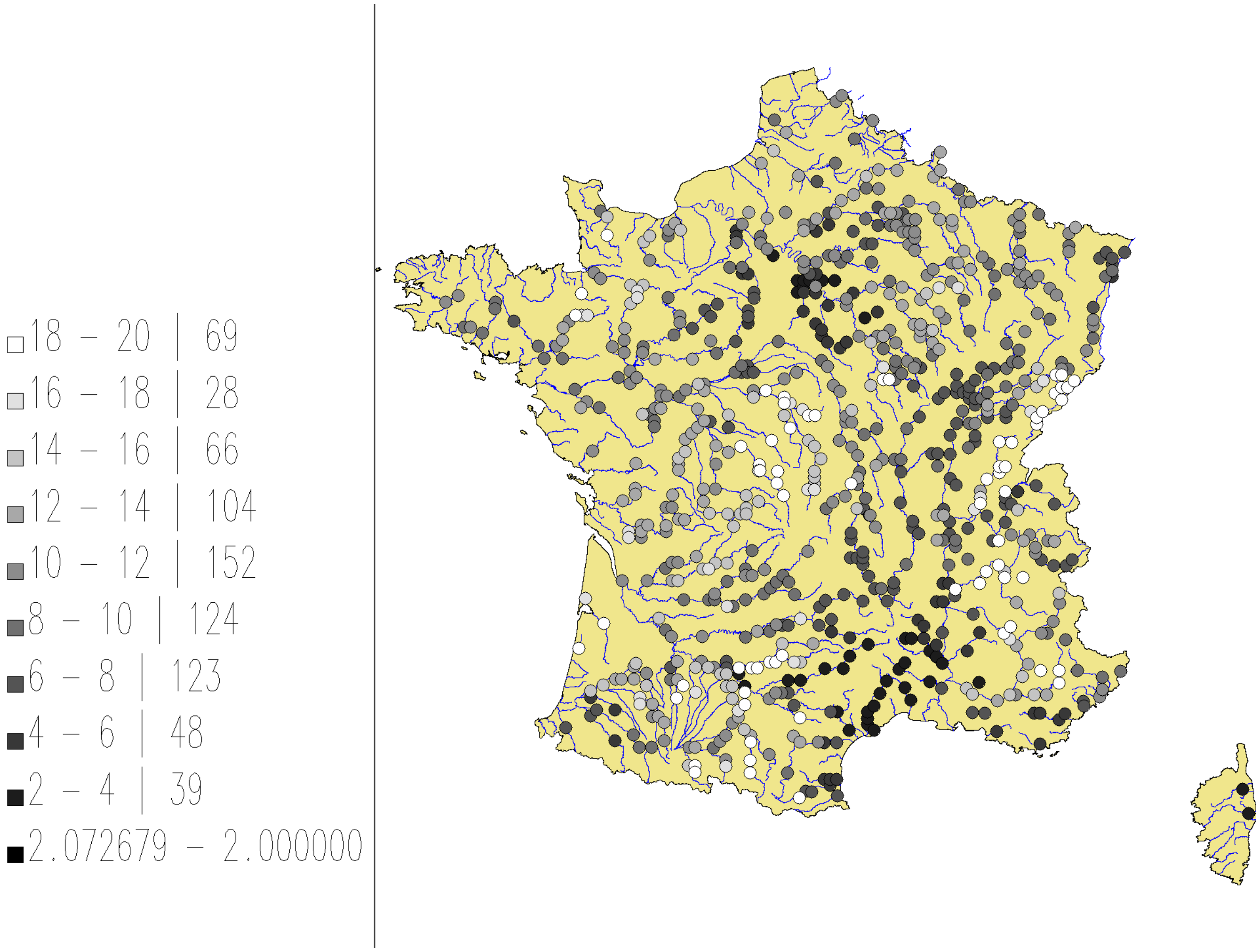

Fig. 12. Return period under climate change associated with the present time 10 years return period level. A Gumbel distribution is used for the statistical analysis, the downscaling technique is QM and the future time period is 2035-2064. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

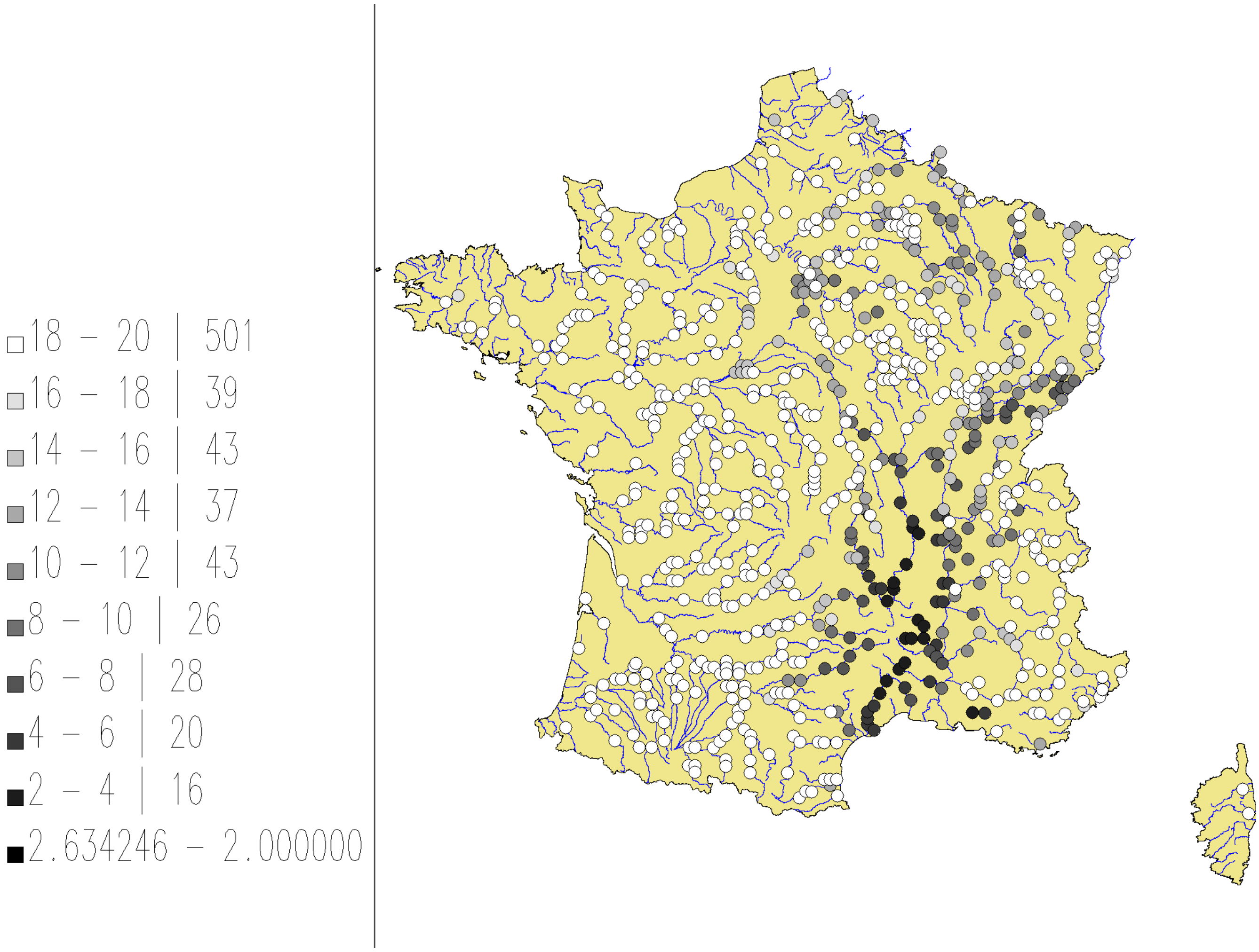

Fig. 13. Return period under climate change associated with the present time 10 years return period level. A Gumbel distribution is used for the statistical analysis, the downscaling technique is WT and the future time period is 2069-2098. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

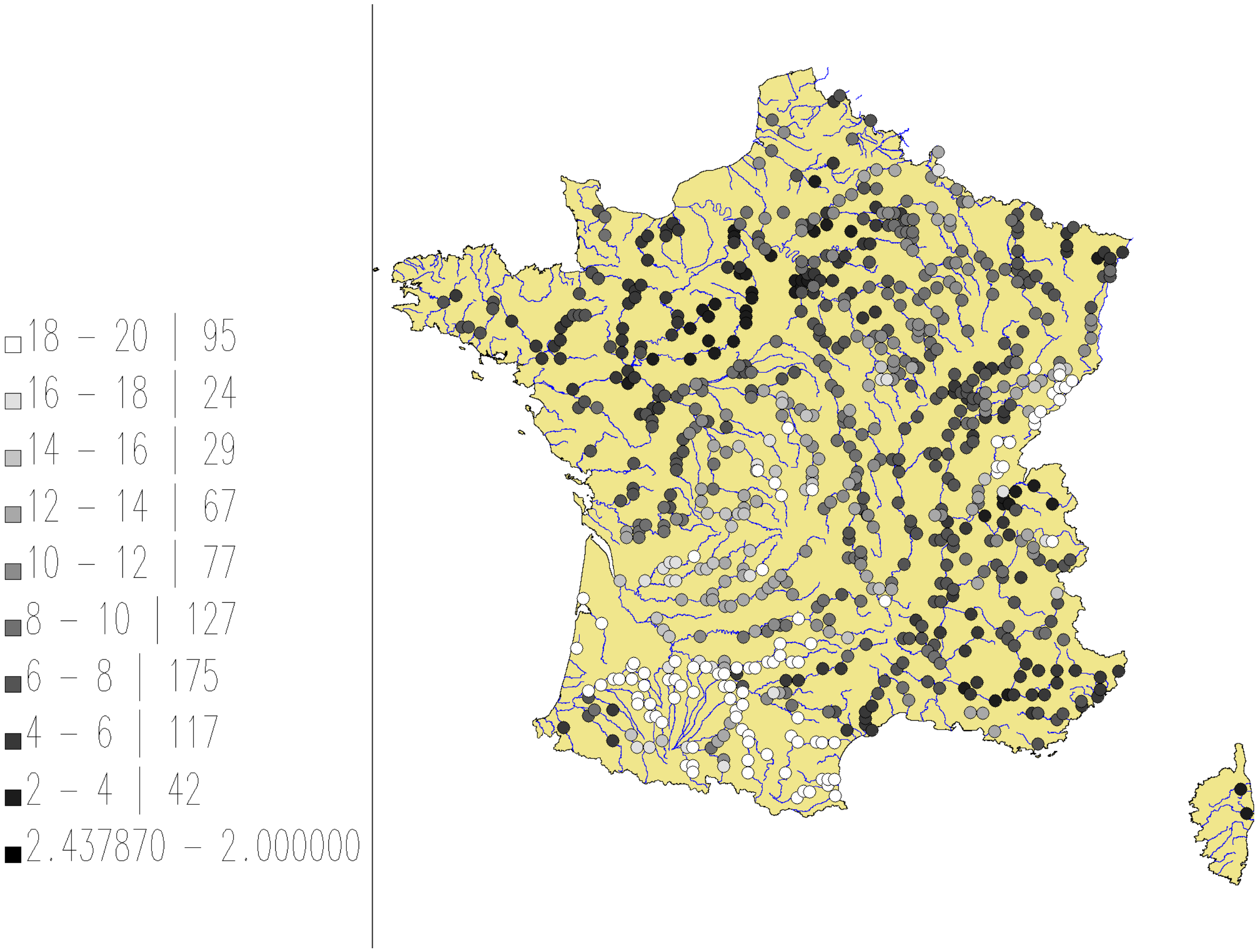

Fig. 14. Return period under climate change associated with the present time 10 years return period level. A Gumbel distribution is used for the statistical analysis, the downscaling technique is QM and the future time period is 2069-2098. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

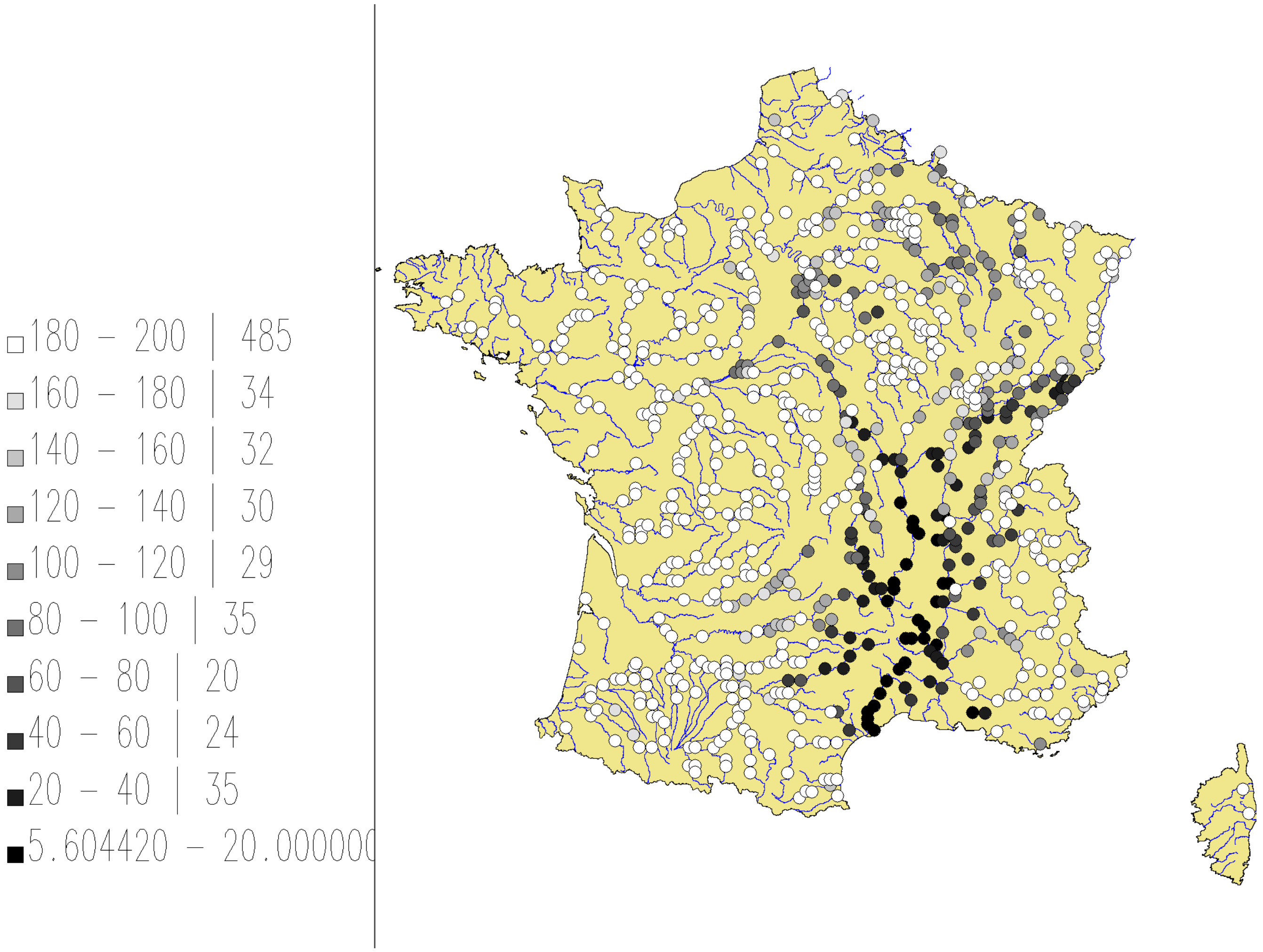

Fig. 15. Return period under climate change associated with the present time 100 years return period level. A Gumbel distribution is used for the statistical analysis, the downscaling technique is WT and the future time period is 2069-2098. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

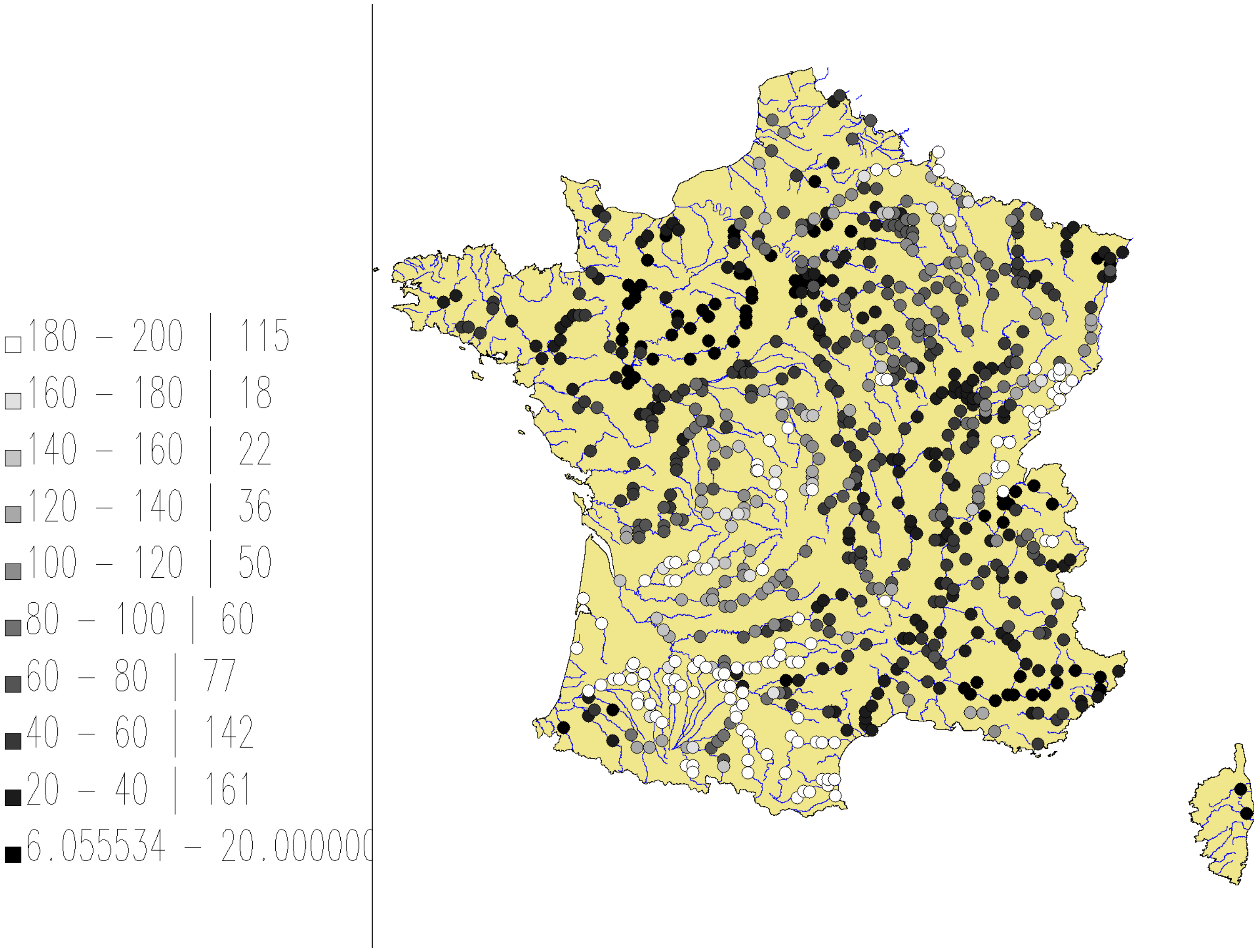

Fig. 16. Return period under climate change associated with the present time 100 years return period level. A Gumbel distribution is used for the statistical analysis, the downscaling technique is QM and the future time period is 2069-2098. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

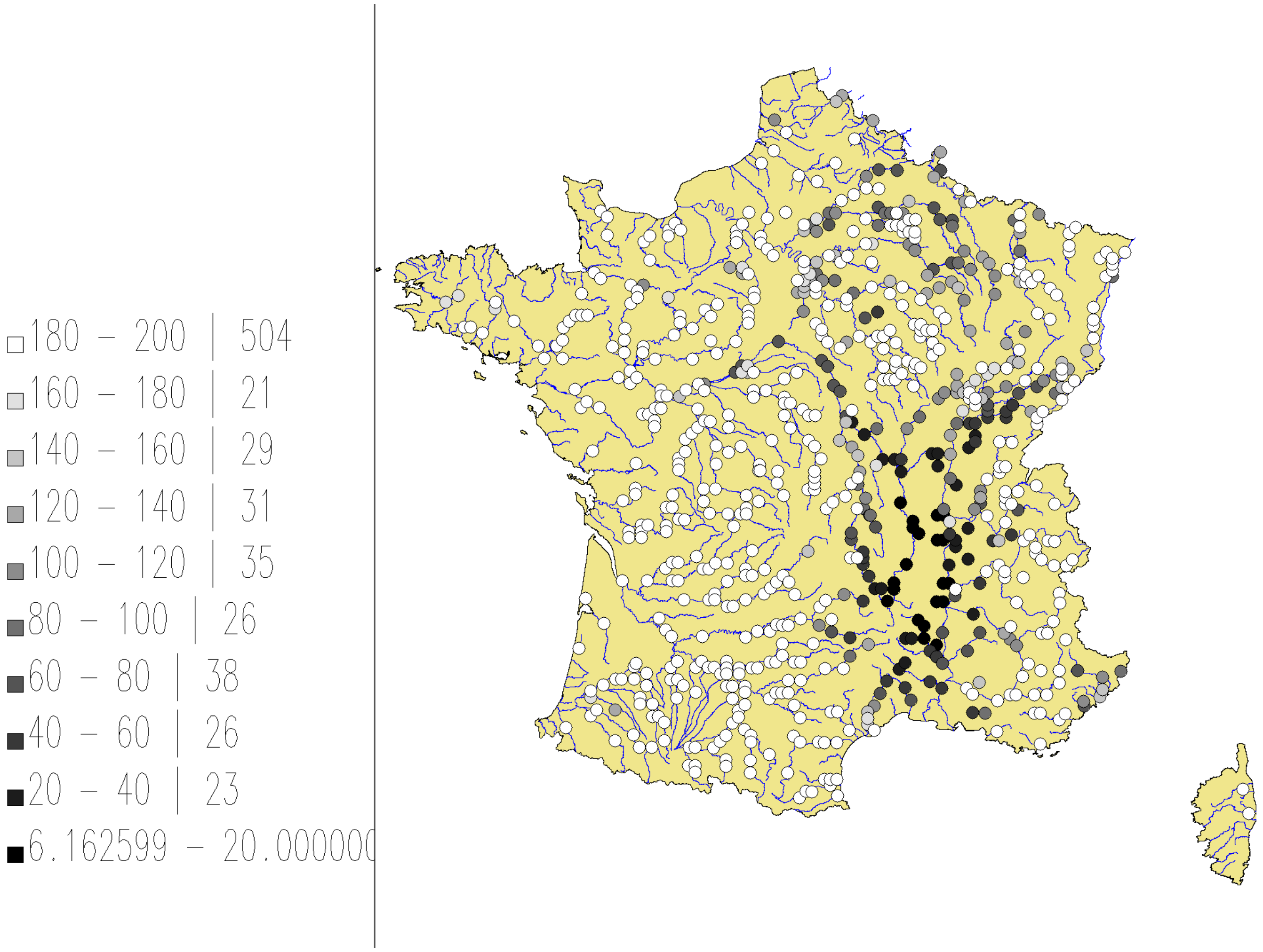

Fig. 17. Return period under climate change associated with the present time 100 years return period level. A Gumbel distribution is used for the statistical analysis, the downscaling technique is WT and the future time period is 2059-2098. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

4 Return period changes with a GEV

Figures 18 to 26 show the return period under climate change corresponding to a present year reference return level, with a GEV distribution used for the statistical analysis. They are referred to in section 3.2.

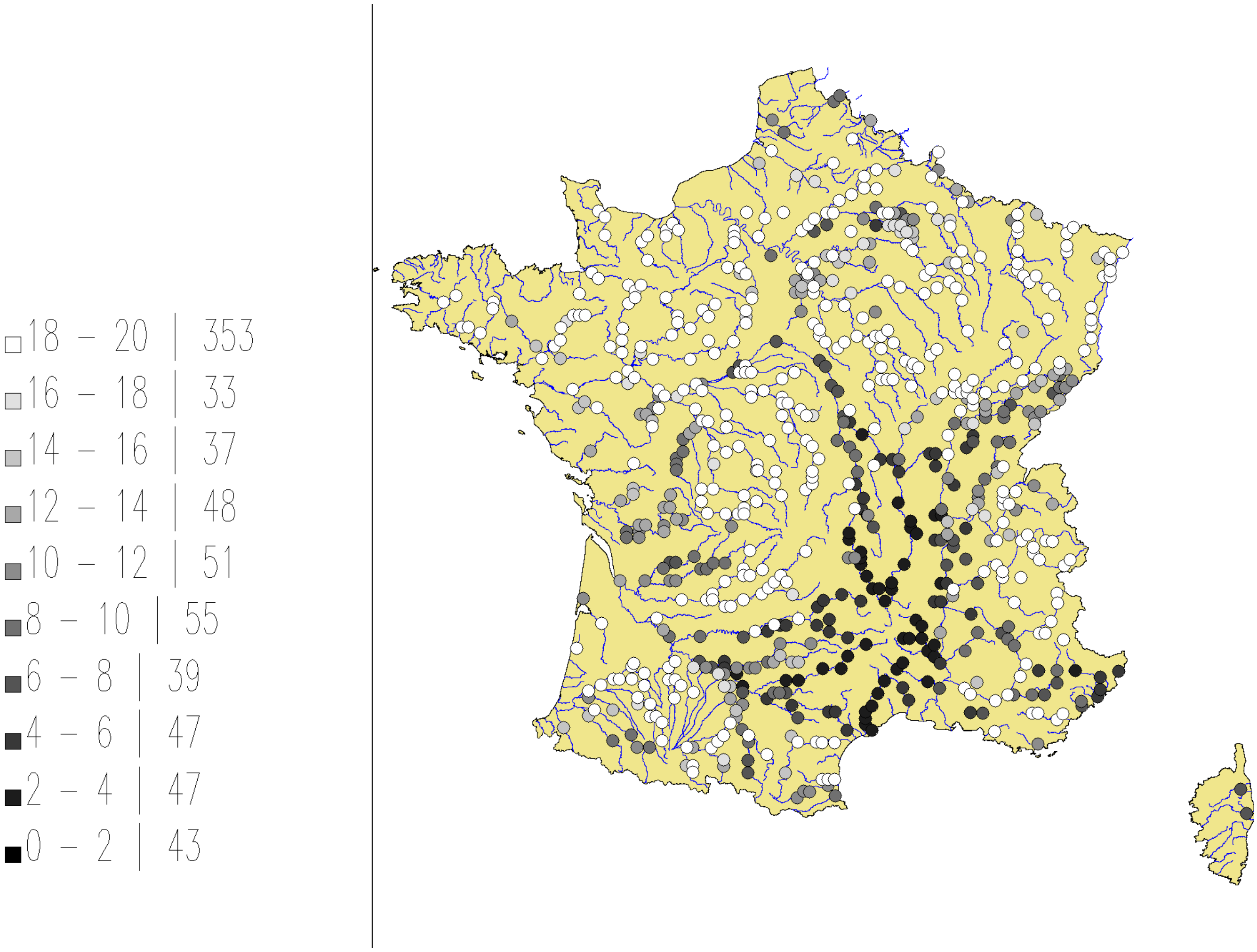

Fig. 18. Return period under climate change associated with the present time 10 years return period level. A GEV distribution is used for the statistical analysis, the downscaling technique is WT and the future time period is 2035-2064. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

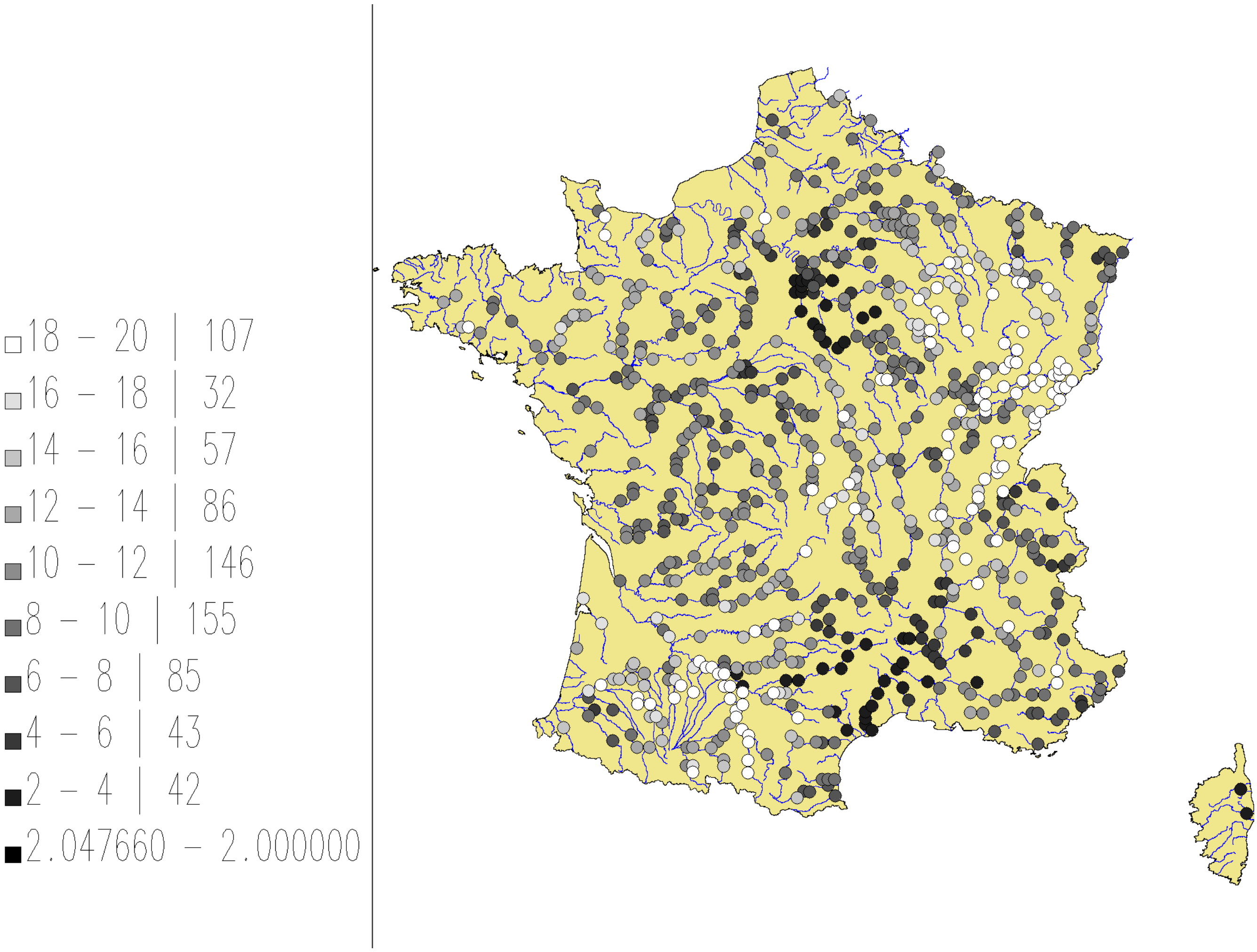

Fig. 19. Return period under climate change associated with the present time 10 years return period level. A GEV distribution is used for the statistical analysis, the downscaling technique is QM and the future time period is 2035-2064. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

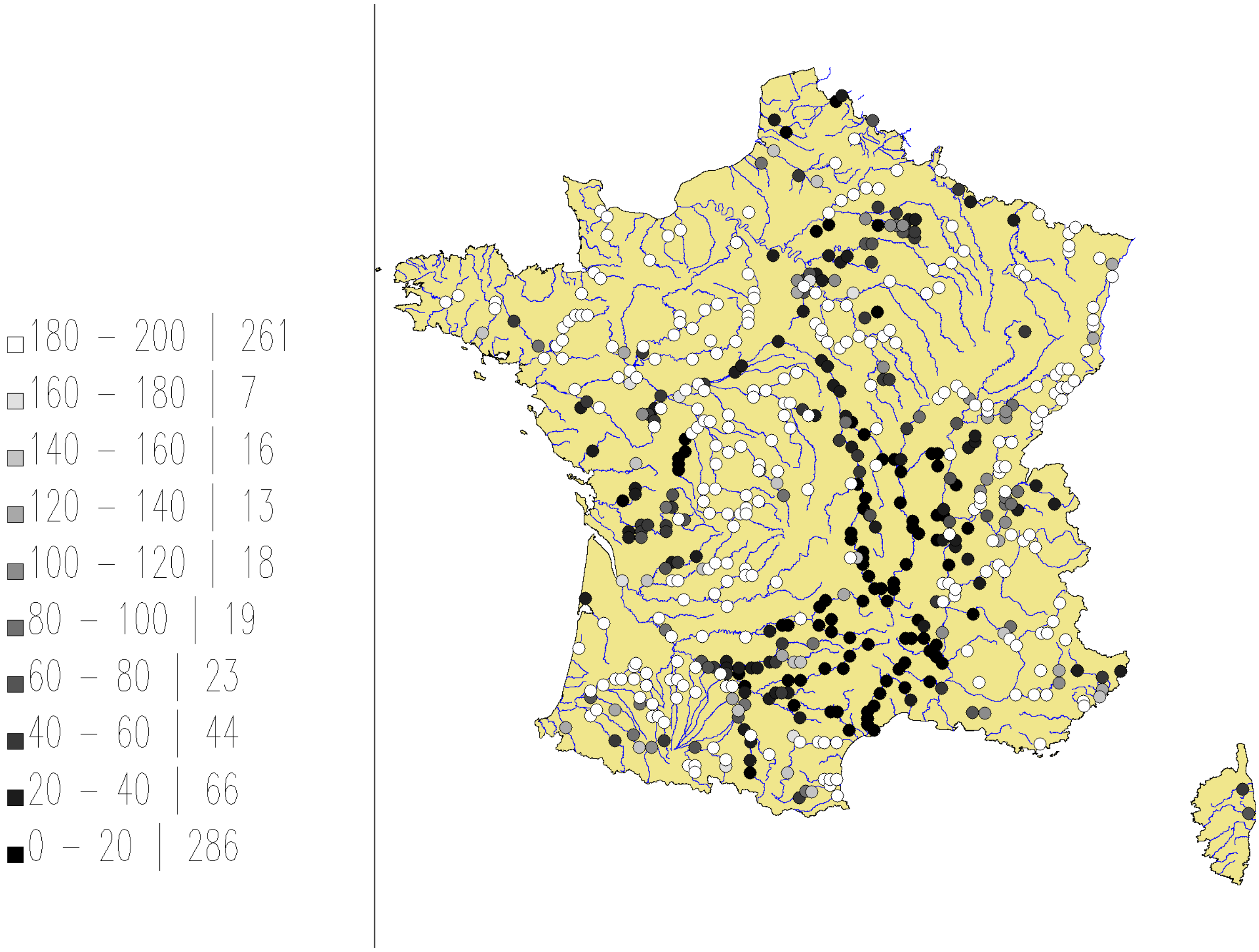

Fig. 20. Return period under climate change associated with the present time 100 years return period level. A GEV distribution is used for the statistical analysis, the downscaling technique is WT and the future time period is 2035-2064. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

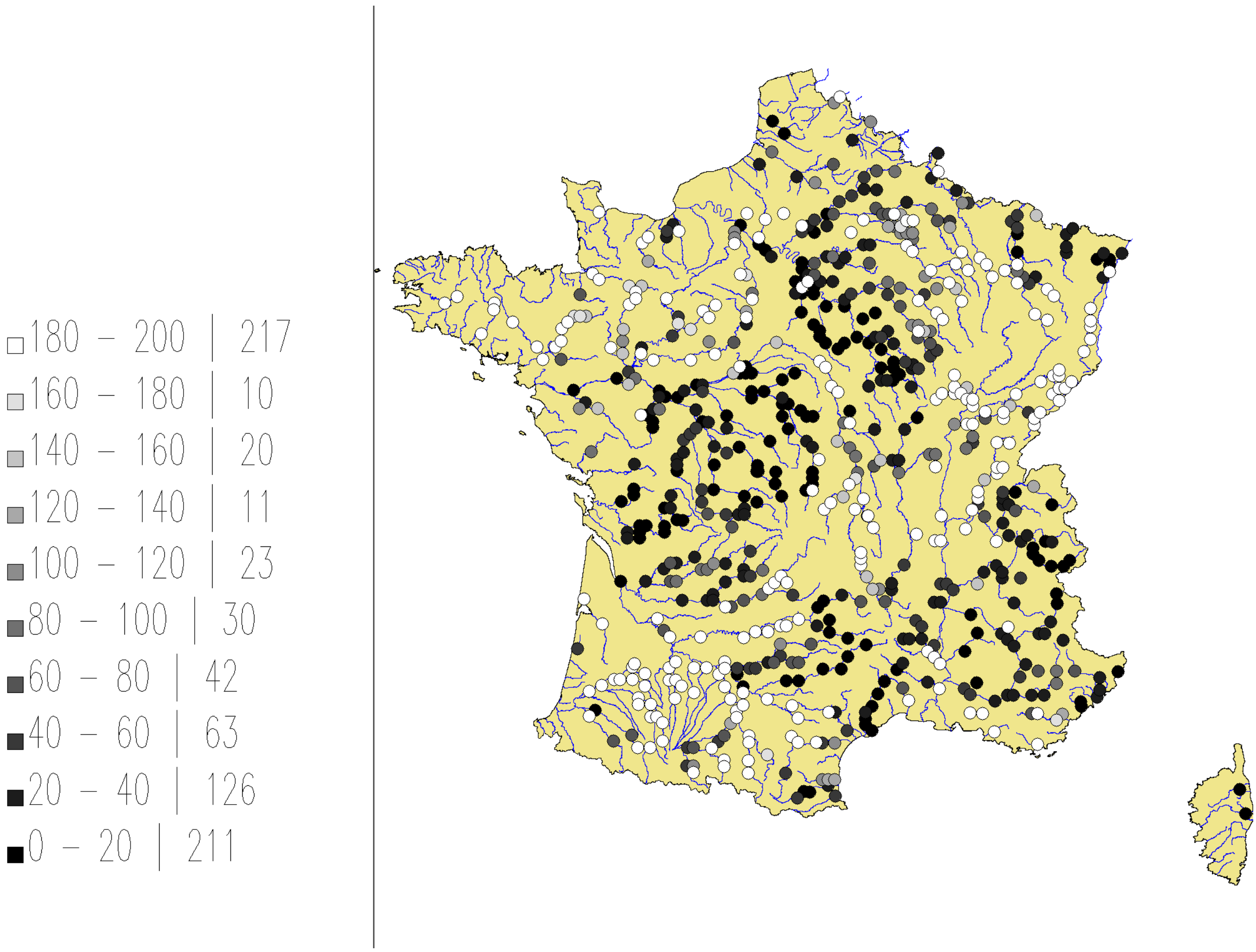

Fig. 21. Return period under climate change associated with the present time 100 years return period level. A GEV distribution is used for the statistical analysis, the downscaling technique is QM and the future time period is 2035-2064. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

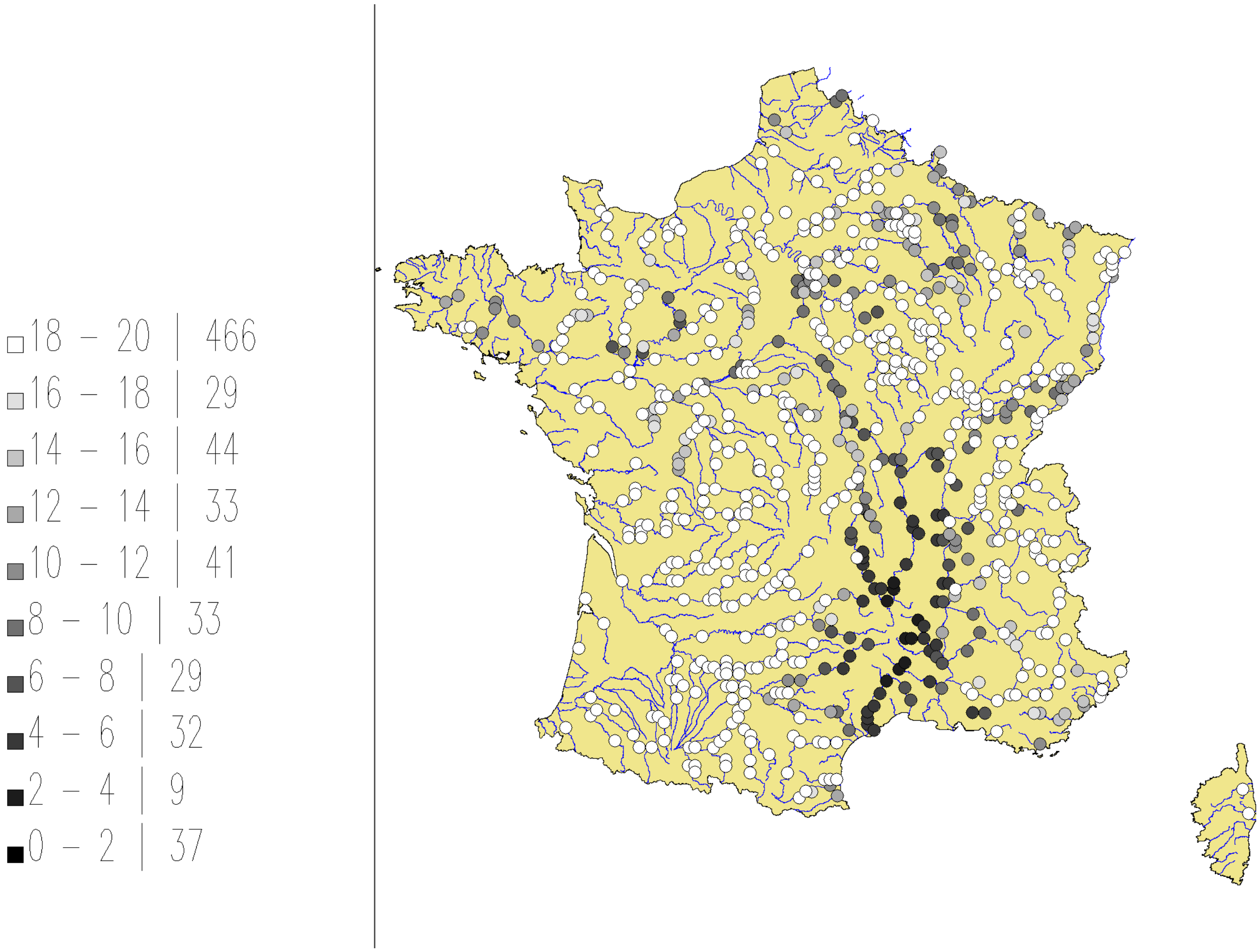

Fig. 22. Return period under climate change associated with the present time 10 years return period level. A GEV distribution is used for the statistical analysis, the downscaling technique is WT and the future time period is 2069-2098. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

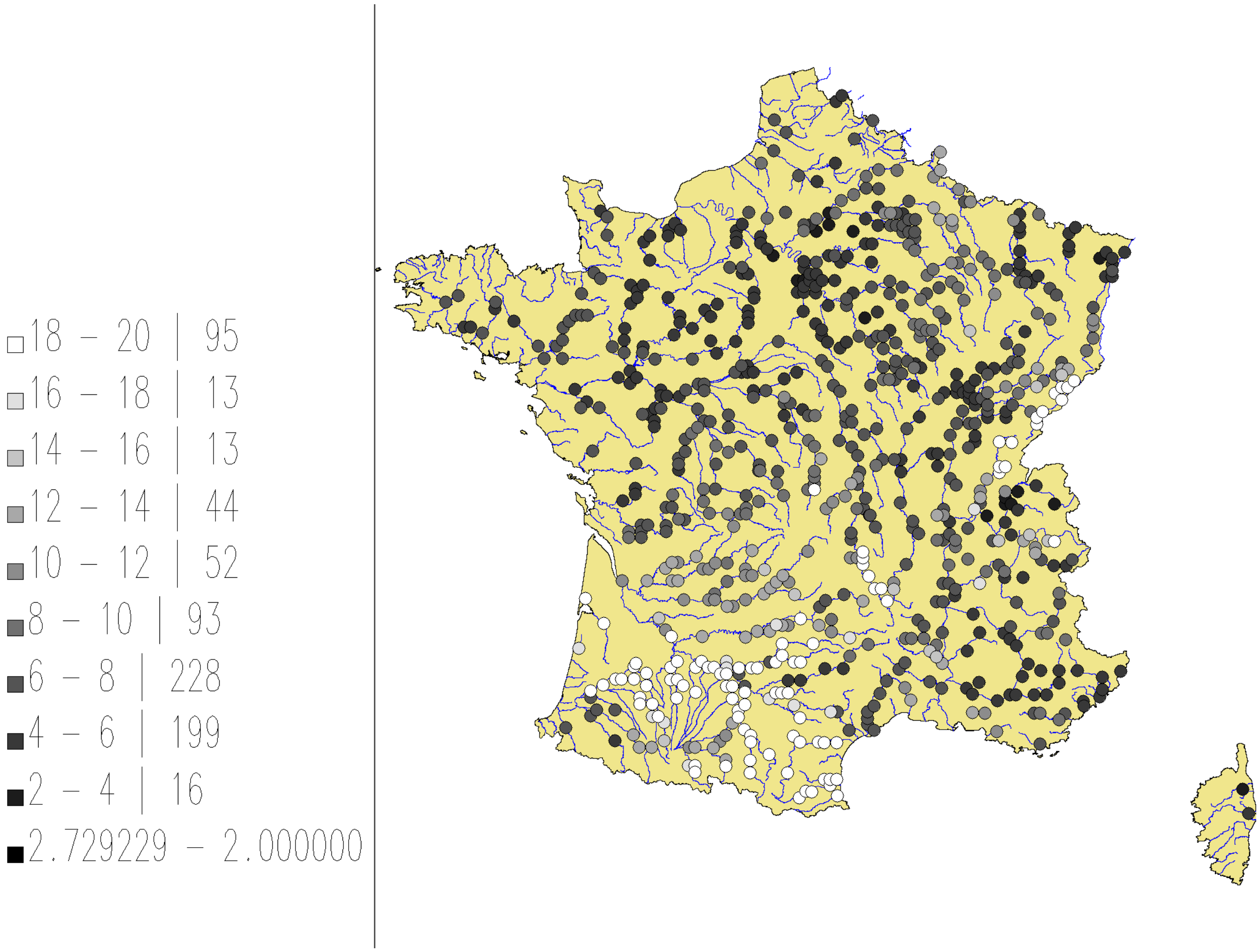

Fig. 23. Return period under climate change associated with the present time 10 years return period level. A GEV distribution is used for the statistical analysis, the downscaling technique is QM and the future time period is 2069-2098. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

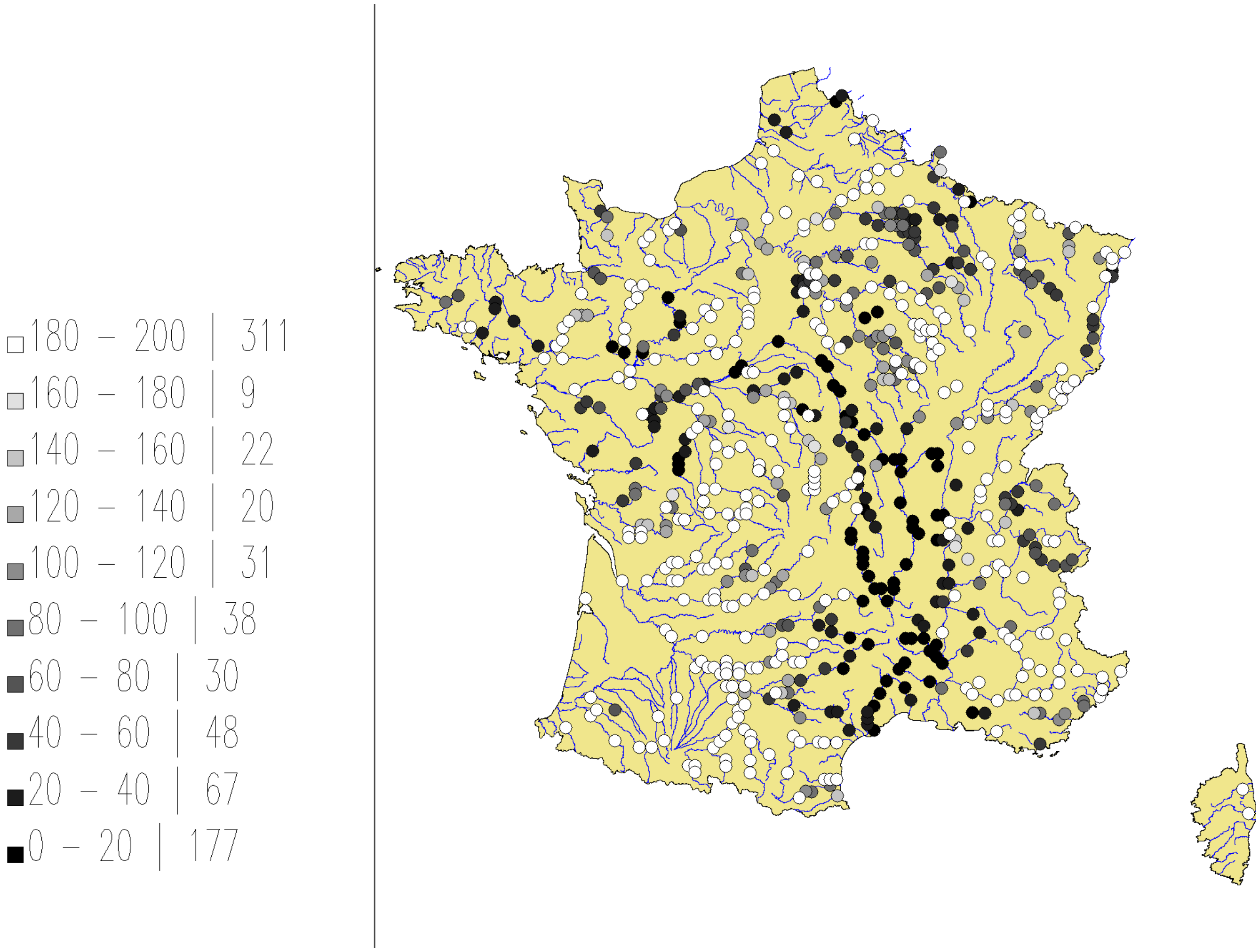

Fig. 24. Return period under climate change associated with the present time 100 years return period level. A GEV distribution is used for the statistical analysis, the downscaling technique is WT and the future time period is 2069-2098. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

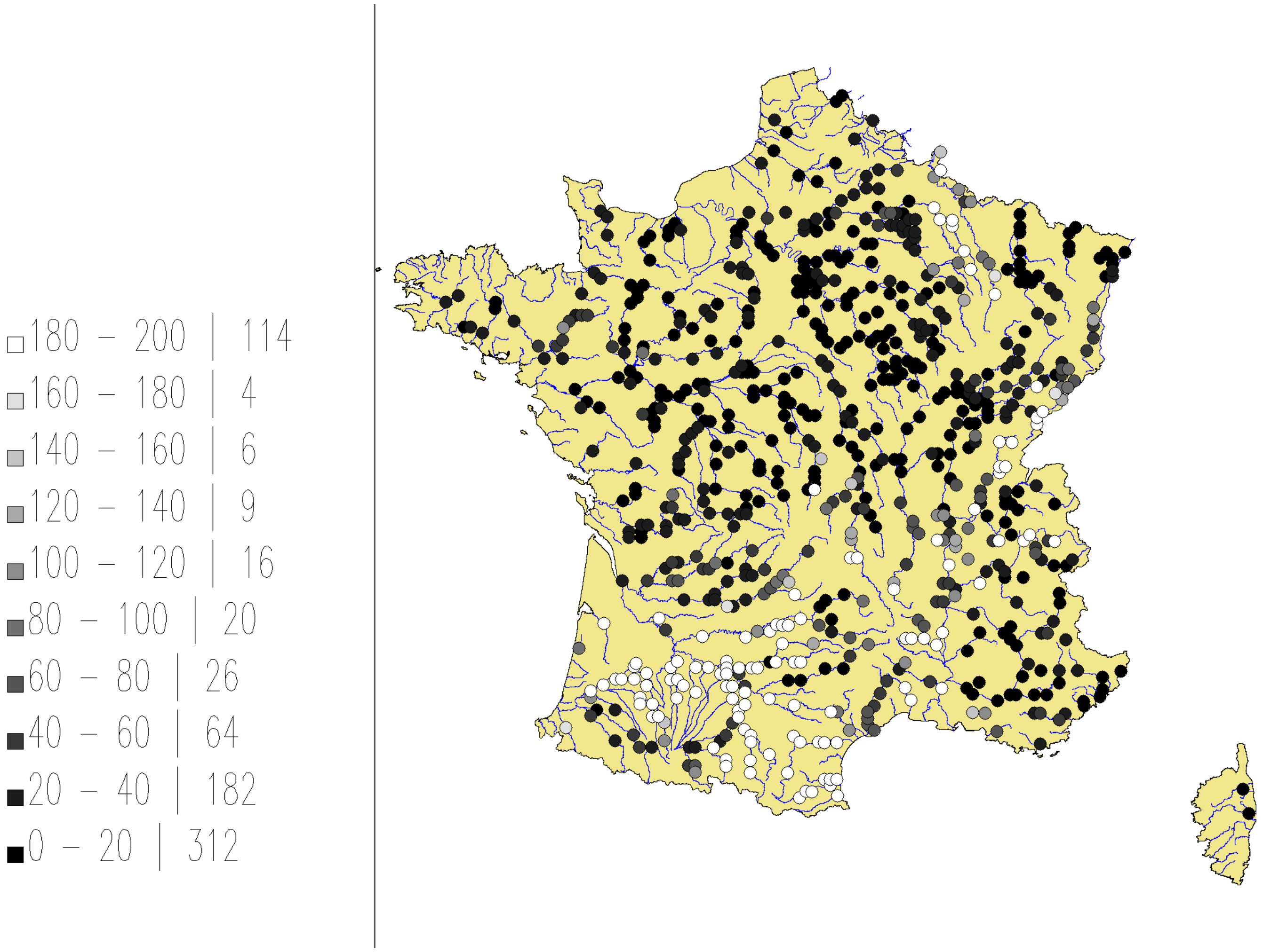

Fig. 25. Return period under climate change associated with the present time 100 years return period level. A GEV distribution is used for the statistical analysis, the downscaling technique is QM and the future time period is 2069-2098. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

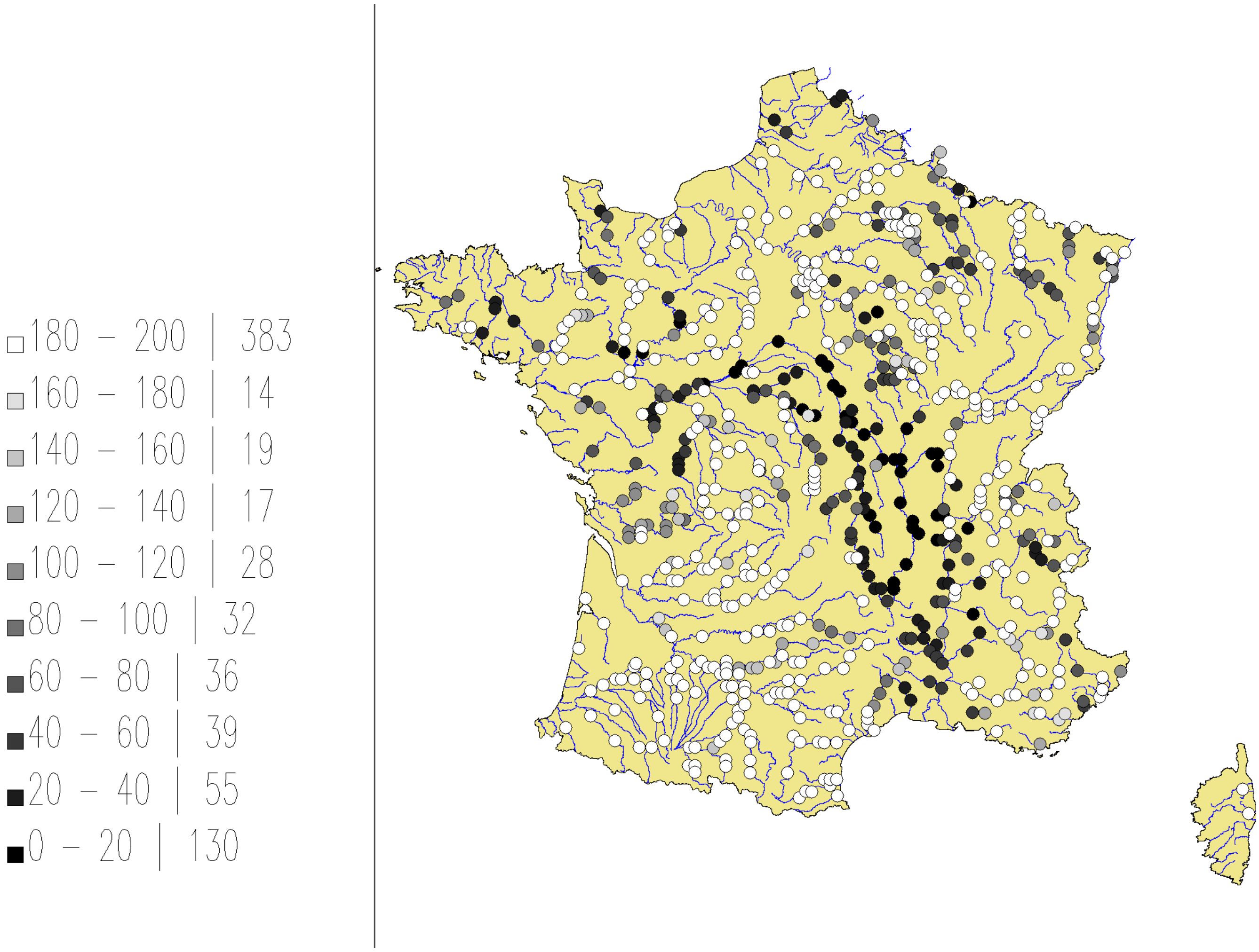

Fig. 26. Return period under climate change associated with the present time 100 years return period level. A GEV distribution is used for the statistical analysis, the downscaling technique is WT and the future time period is 2059-2098. Increases in return period above doubling (e.g., the probability is divided by more than 2) are figured as doubling.

5 Current costs

Figures 27 to 29 show the expected current cost of floods.
They are referred to in section 3.3.

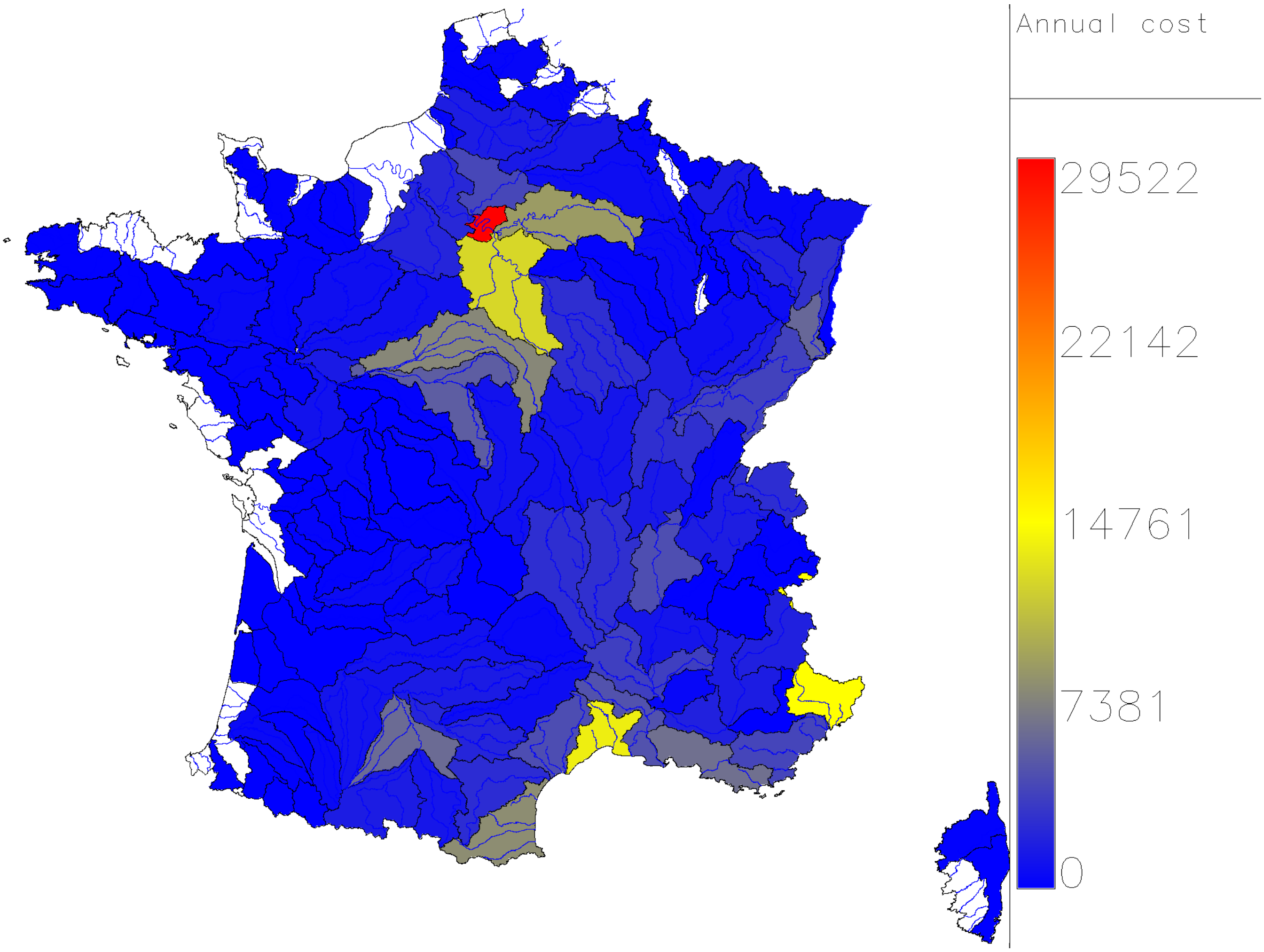

Fig. 27. The color of the areas correspond to the current expected annual losses, indicating the importance of each area. The loss-ratio assumption is based on MEDD losses.

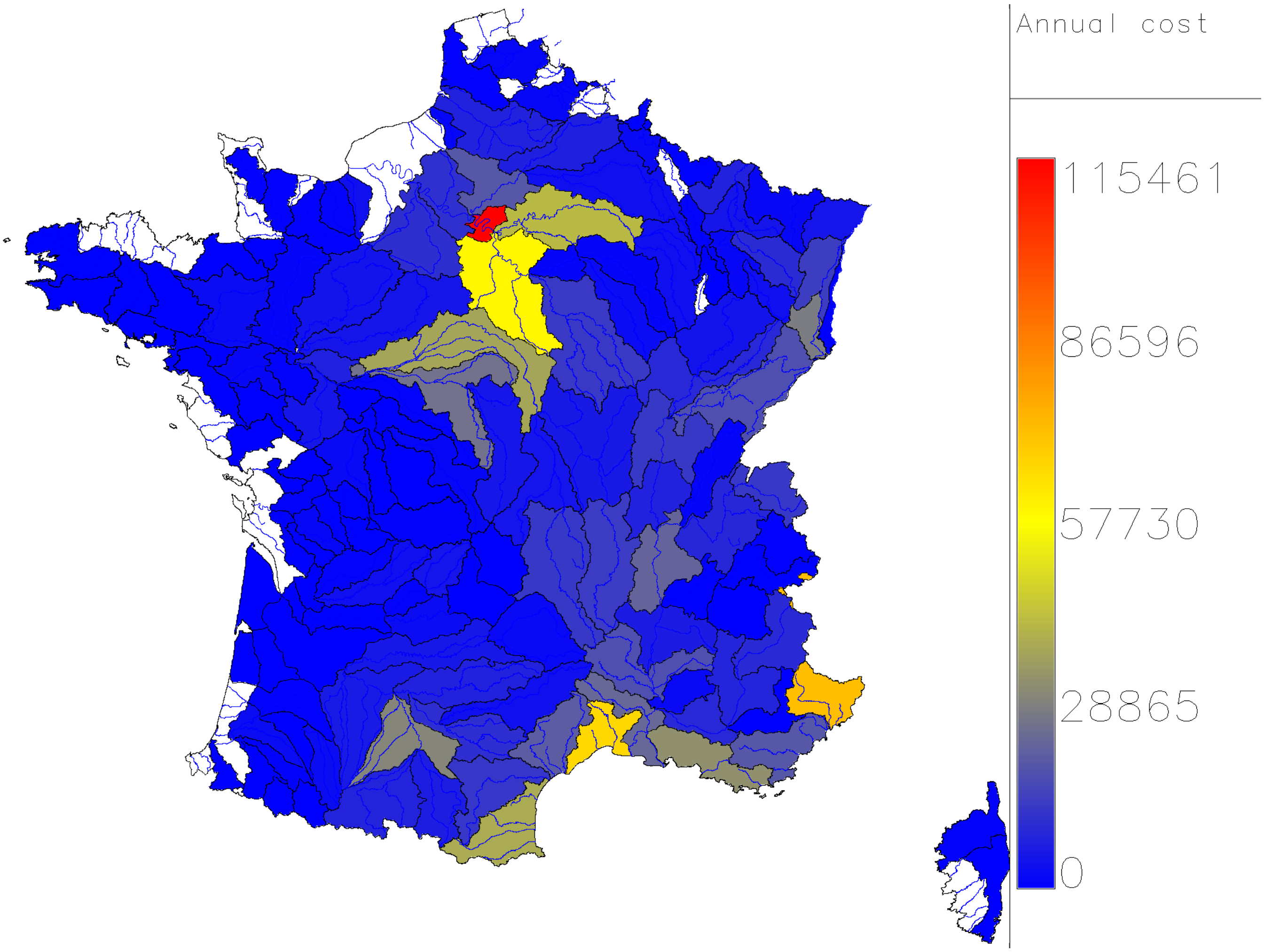

Fig. 28. The color of the areas correspond to the current expected annual losses, indicating the importance of each area. The loss-ratio assumption is based on 30% uniform losses.

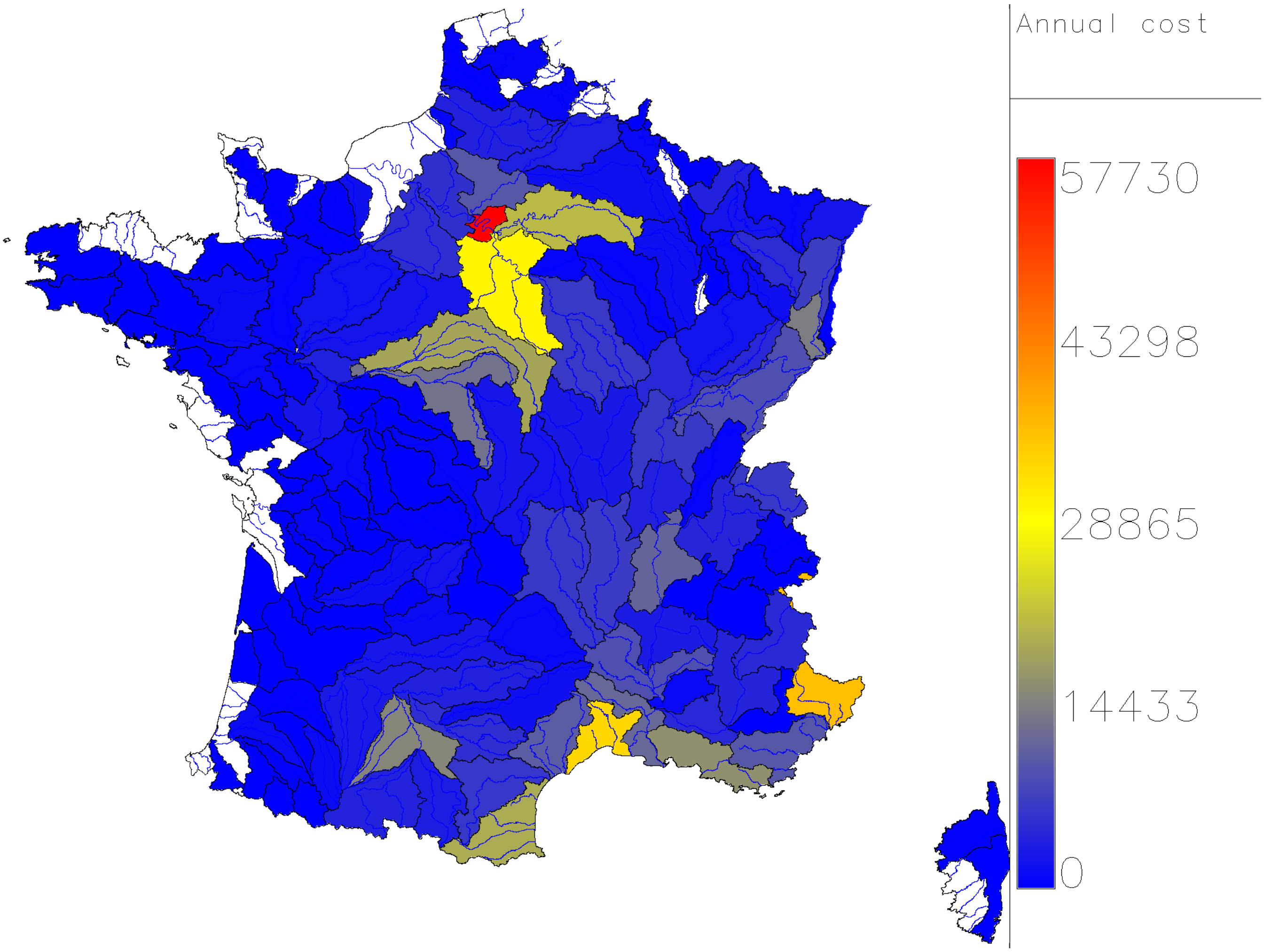

Fig. 29. The color of the areas correspond to the current expected annual losses, indicating the importance of each area. The loss-ratio assumption is based on 15% uniform losses.

6 Cost change

Figures 30 to 36 show the relative change of flood losses, in percent. They are referred to in section 3.3.

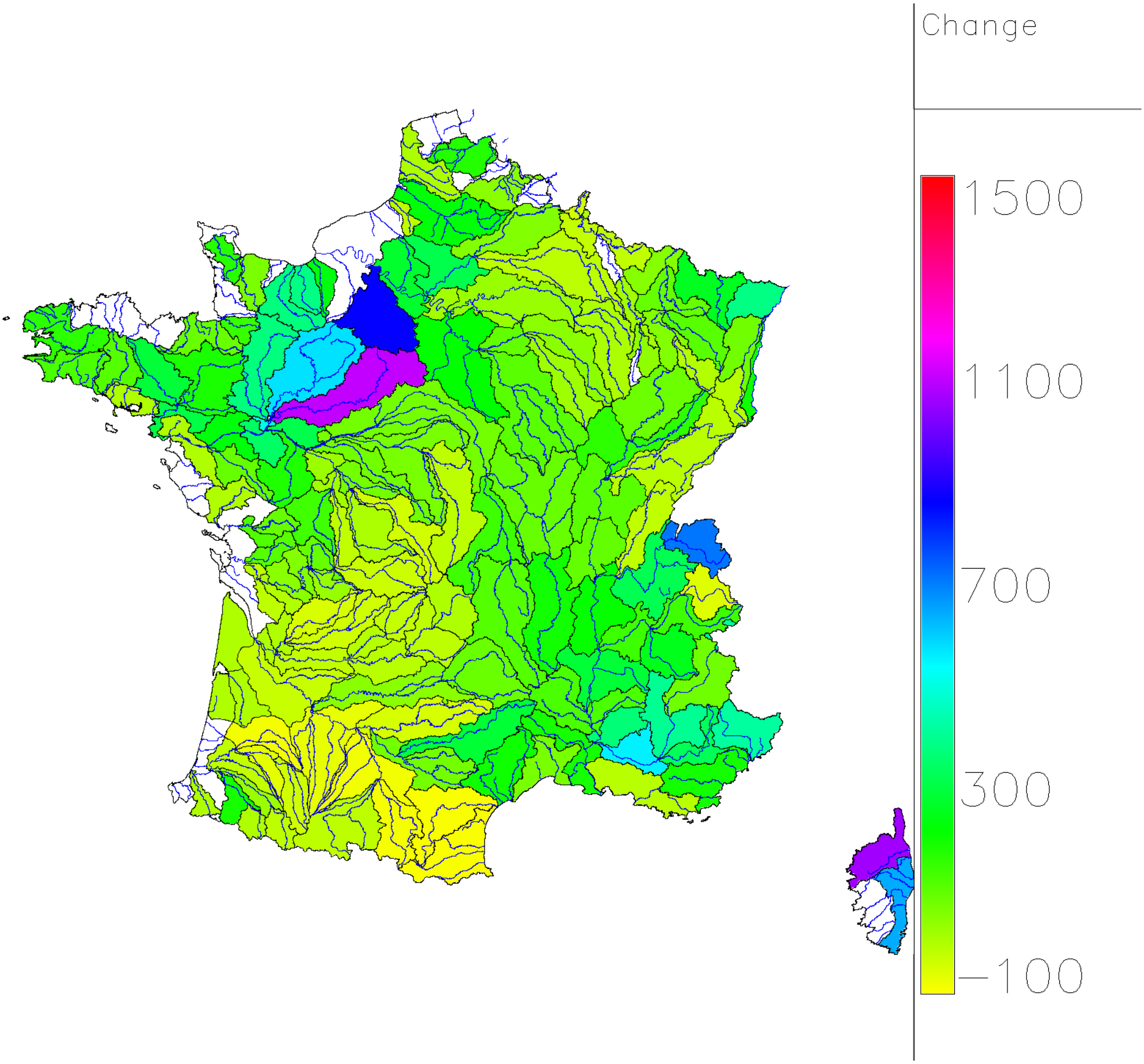

Fig. 30. The color of the areas correspond to changes in flood losses, in percent. Reference return period is 100 years. The result presented here correspond to QMS scenario, comparing costs in 1970-1999 and 2069-2098; the loss-ratio assumption is based on 15% uniform losses; a Gumbel distribution is used for the statistical analysis.

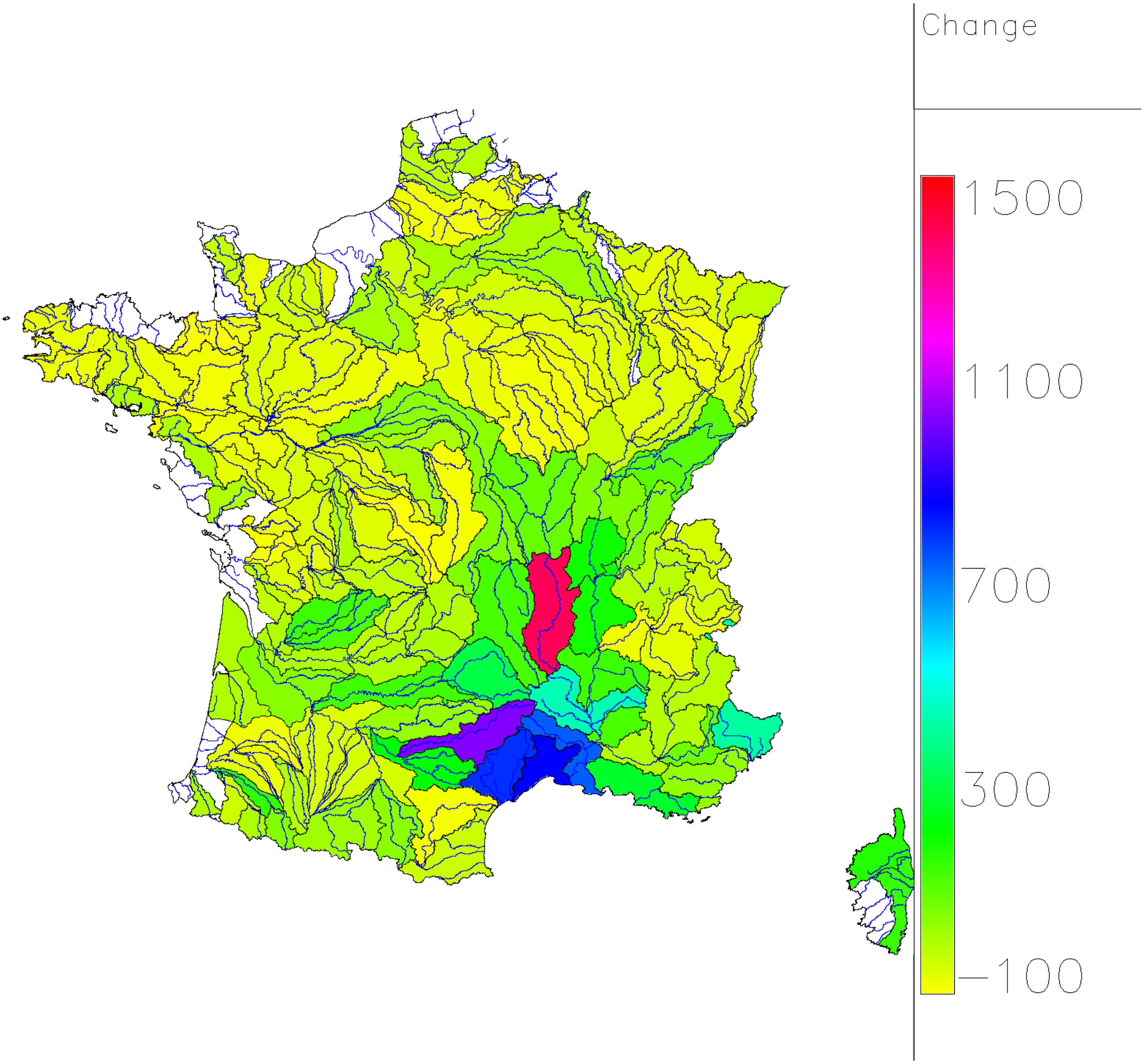

Fig. 31. The color of the areas correspond to changes in flood losses, in percent. Reference return period is 100 years. The result presented here correspond to WTS scenario, comparing costs in 1970-1999 and 2035-2064; the loss-ratio assumption is based on Var losses; a Gumbel distribution is used for the statistical analysis.

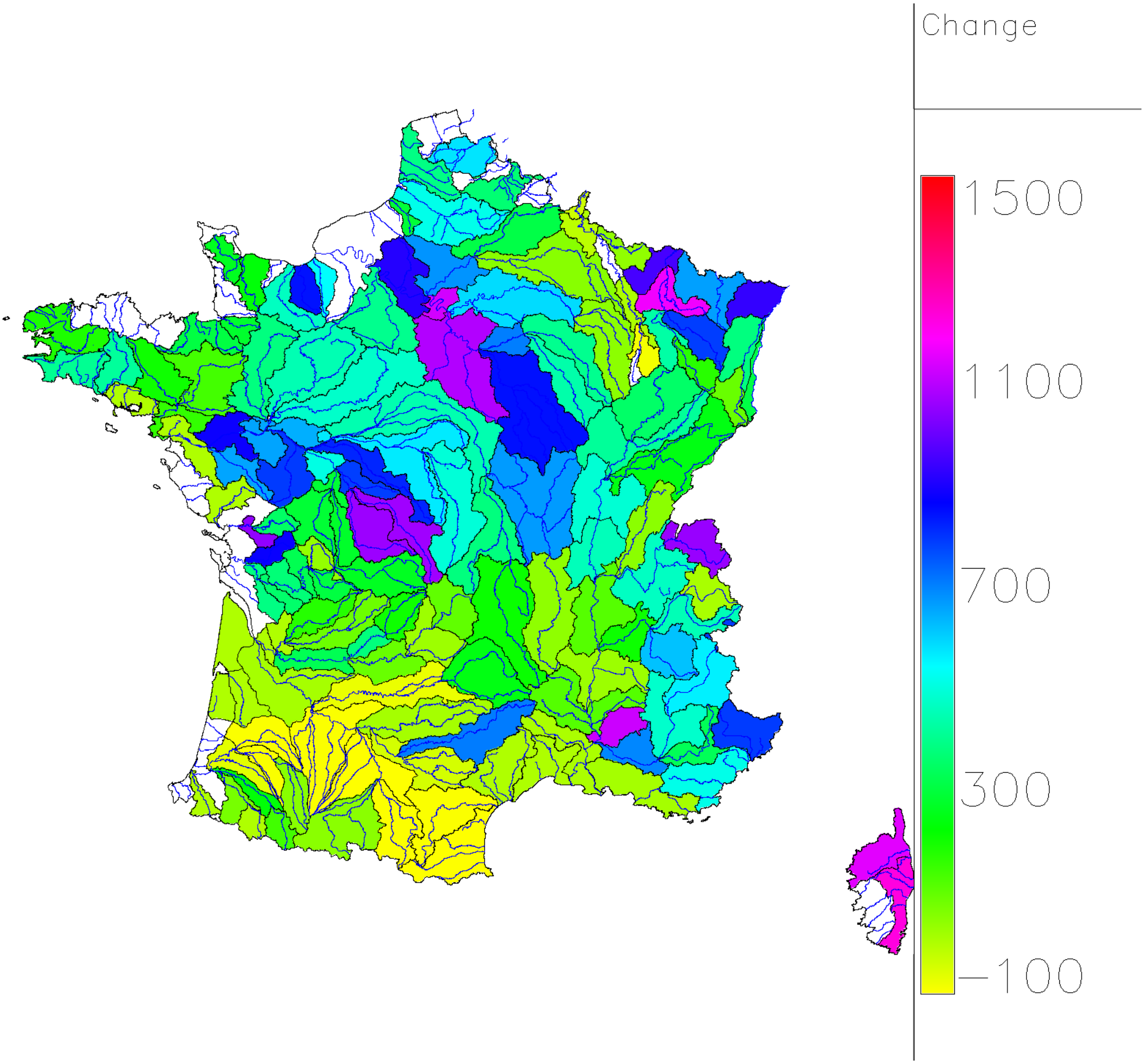

Fig. 32. The color of the areas correspond to changes in flood losses, in percent. Reference return period is 100 years. The result presented here correspond to QMS scenario, comparing costs in 1970-1999 and 2069-2098; the loss-ratio assumption is based on Var losses; a GEV distribution is used for the statistical analysis.

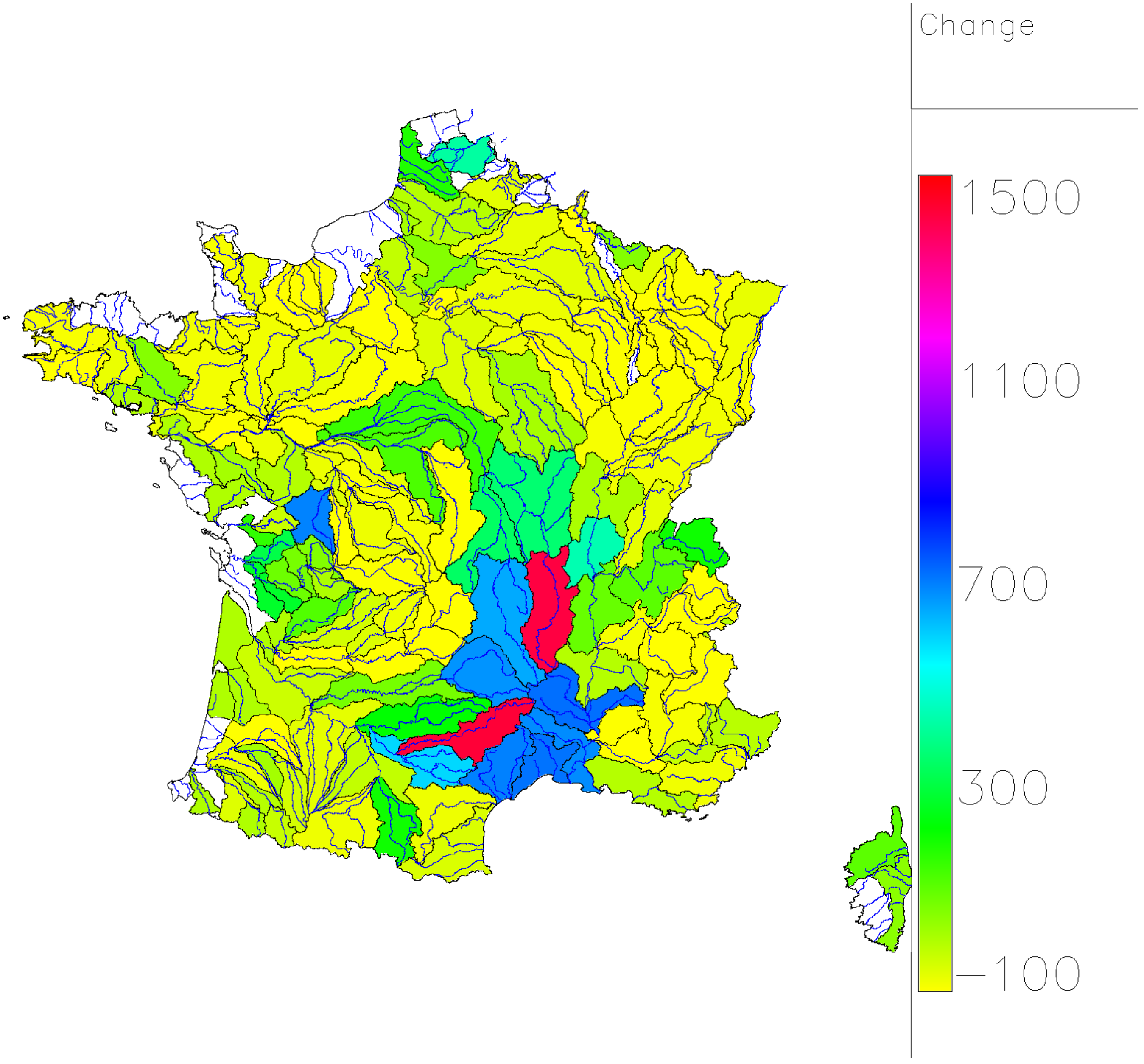

Fig. 33. The color of the areas correspond to changes in flood losses, in percent. Reference return period is 100 years. The result presented here correspond to WTS scenario, comparing costs in 1970-1999 and 2035-2064; the loss-ratio assumption is based on Var losses; a GEV distribution is used for the statistical analysis.

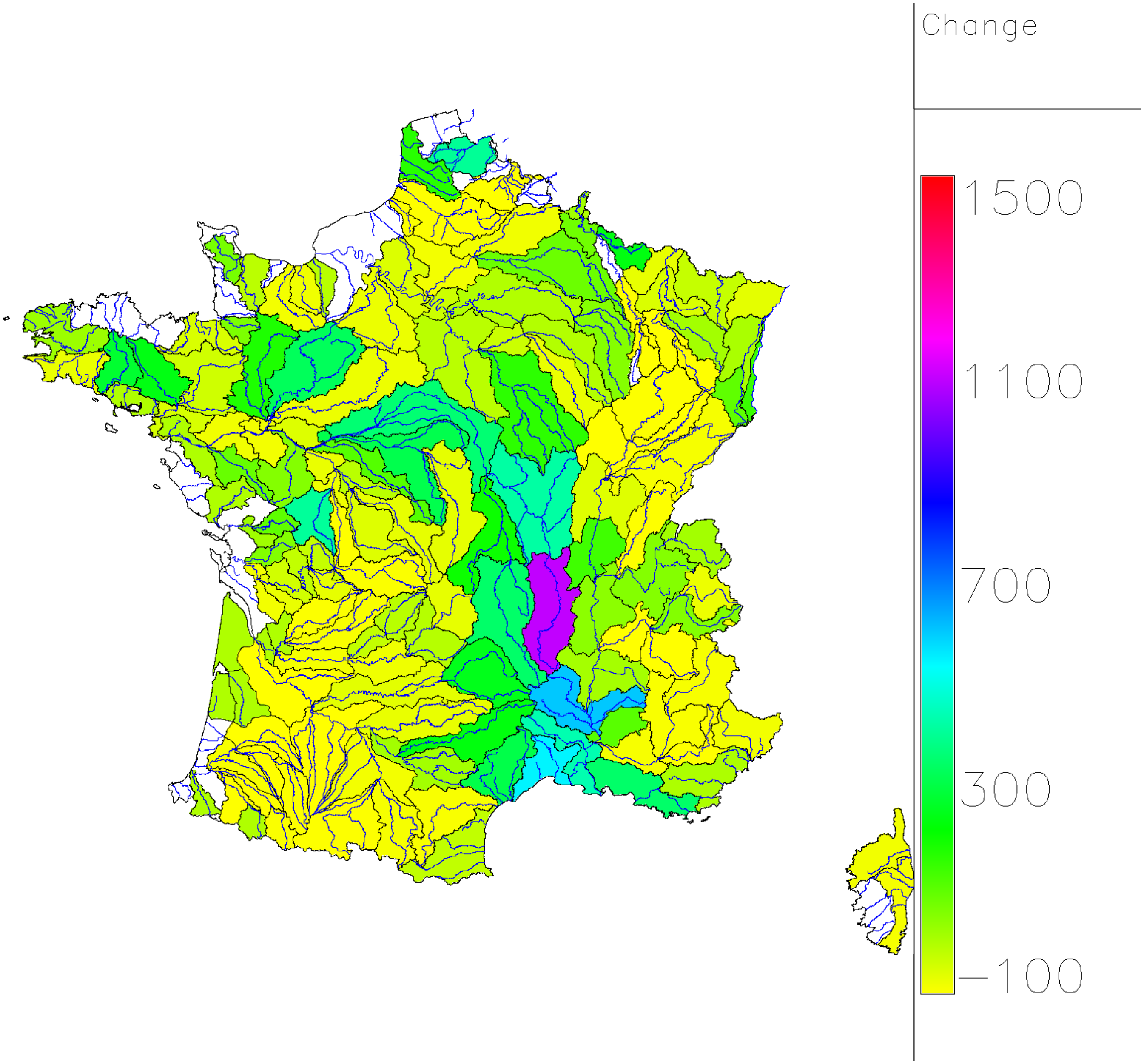

Fig. 34. The color of the areas correspond to changes in flood losses, in percent. Reference return period is 100 years. The result presented here correspond to WTS scenario, comparing costs in 1970-1999 and 2069-2098; the loss-ratio assumption is based on Var losses; a GEV distribution is used for the statistical analysis.

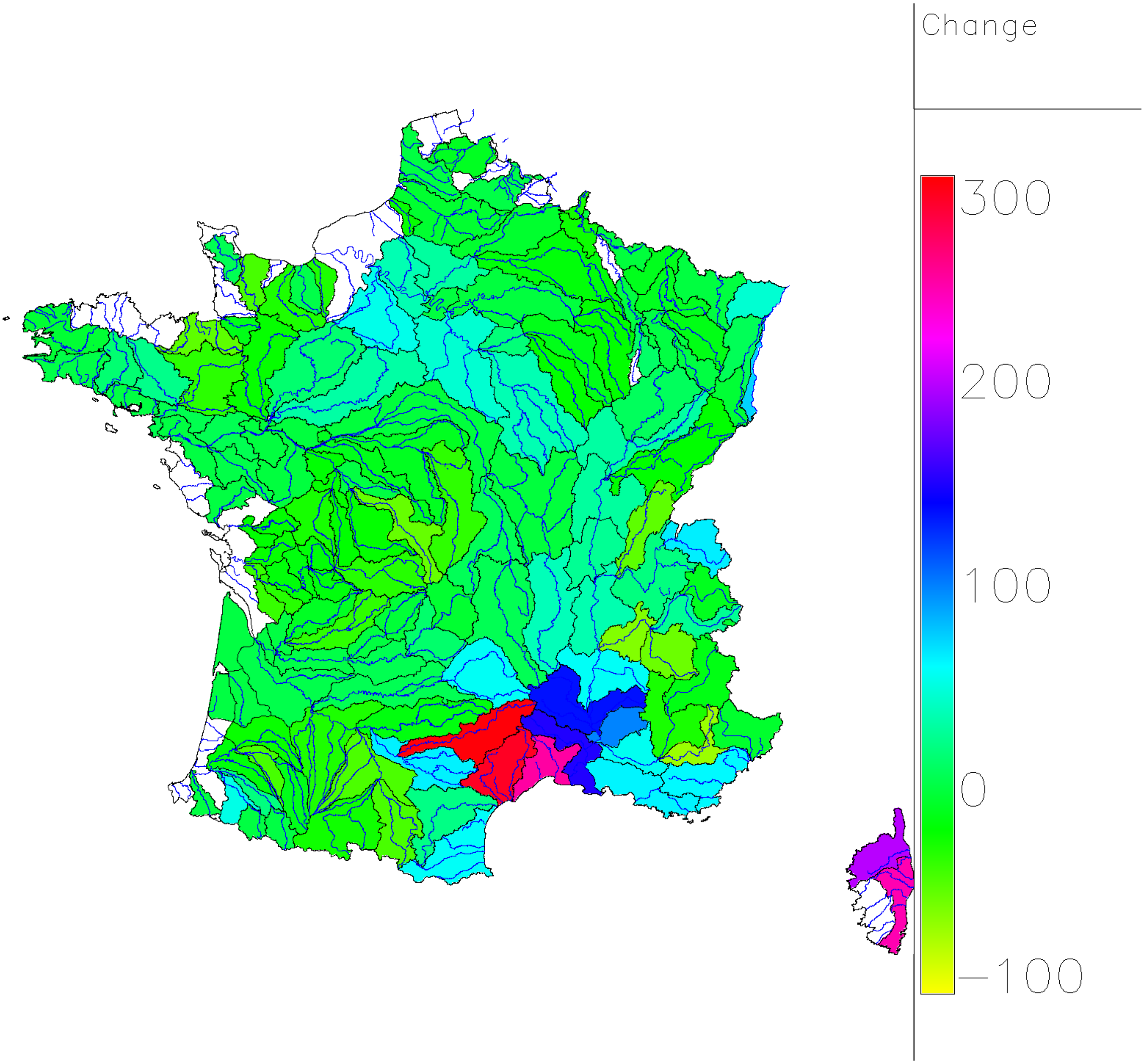

Fig. 35. The color of the areas correspond to changes in flood losses, in percent. Reference return period is 10 years. The result presented here correspond to QMS scenario, comparing costs in 1970-1999 and 2035-2064; the loss-ratio assumption is based on Var losses; a Gumbel distribution is used for the statistical analysis.

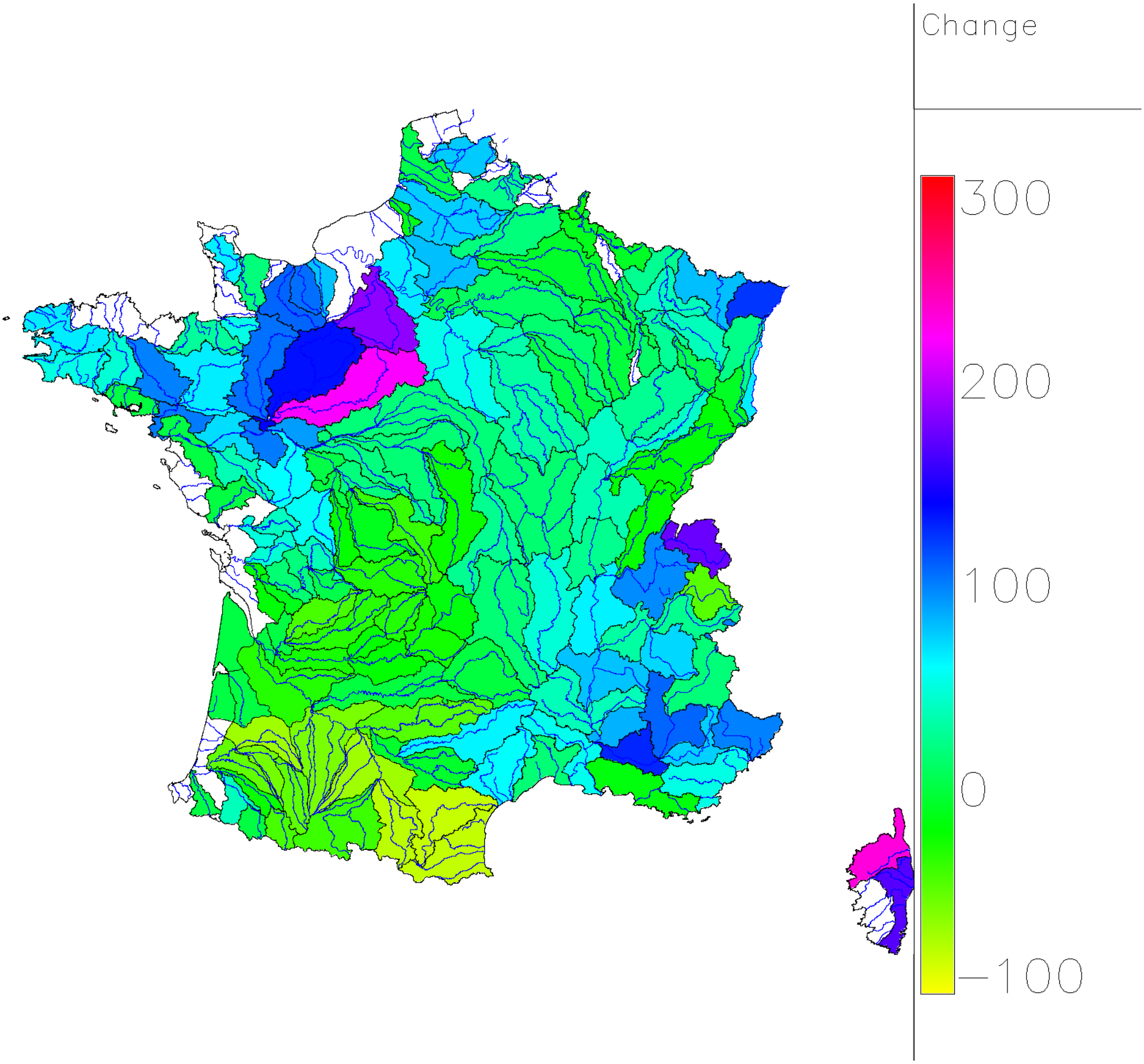

Fig. 36. The color of the areas correspond to changes in flood losses, in percent. Reference return period is 10 years. The result presented here correspond to QMS scenario, comparing costs in 1970-1999 and 2069-2098; the loss-ratio assumption is based on Var losses; a Gumbel distribution is used for the statistical analysis.