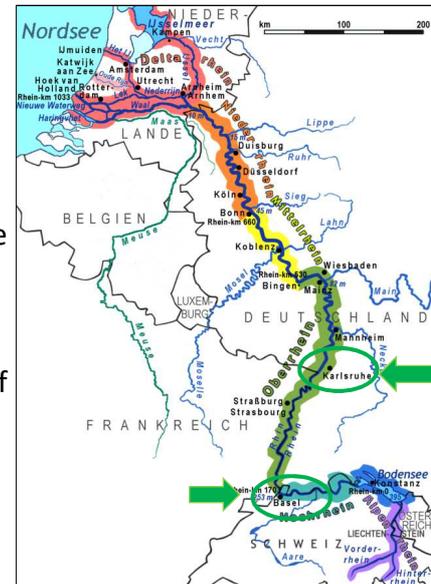


## Hydrological consistency between the upstream and downstream estimates of $Q_{1000}$ flood on the upper Rhine River, using historical series in Basel (1808-2017) and Maxau (1815-2018)

1. Long discharge flood series on the upper Rhine (Basel/Maxau)
2. Uncertainty analysis of flood discharge
3. Local estimation of flood distributions (Basel/Maxau)
4. Hydrological consistency with a regional shape parameter of the GEV distribution
5. Conclusion



Michel Lang, Benjamin Renard, Jérôme Le Coz

EGU 2021 meeting, session HS2.4.4 - 'Hydrological extremes: from droughts to floods', 27 April 2021

1

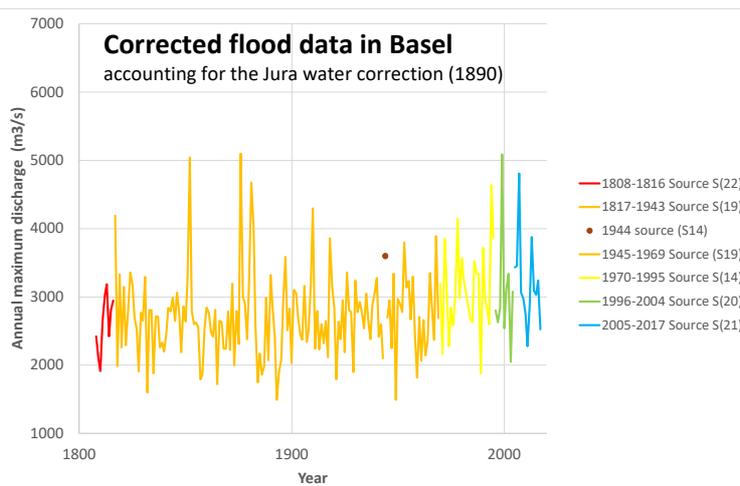
Long series in Basel and Maxau

Uncertainty on flood discharge

Local flood distribution

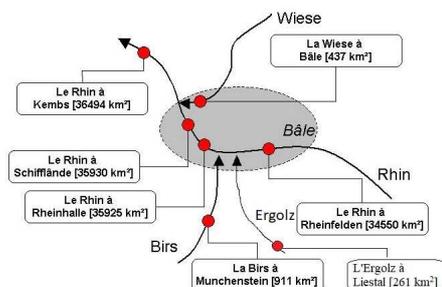
Hydrological consistency with a regional GEV distribution

## Long series of annual maximum discharge in Basel : 1808-2017



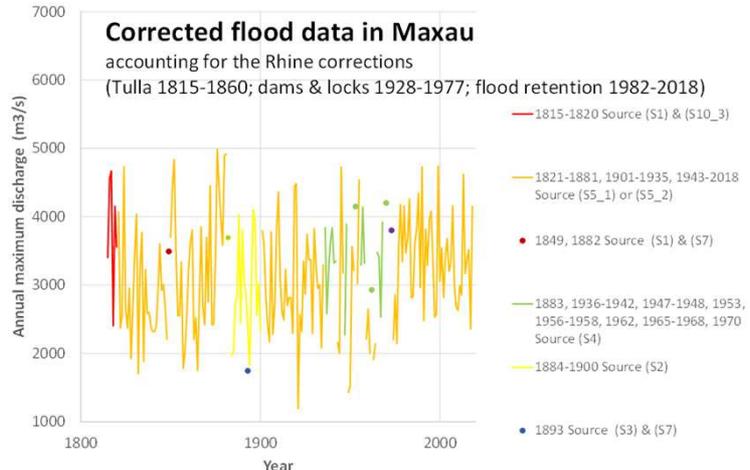
### 3 stations

- **Schifflände : 1808-1932**  
« historical » station
- **Rheinfelden : 1933-1994**  
since influence of Kembs dam
- **Rheinhalle : 1995-2017**  
« modern » station



Long series in Basel and Maxau	Uncertainty on flood discharge	Local flood distribution	Hydrological consistency with a regional GEV distribution
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## Long series of annual maximum discharge in Maxau : 1815-2018



**Corrected flood data in Maxau**  
accounting for the Rhine corrections  
(Tulla 1815-1860; dams & locks 1928-1977; flood retention 1982-2018)

- 1815-1820 Source (S1) & (S10\_3)
- 1821-1881, 1901-1935, 1943-2018 Source (S5\_1) or (S5\_2)
- 1849, 1882 Source (S1) & (S7)
- 1883, 1936-1942, 1947-1948, 1953, 1956-1958, 1962, 1965-1968, 1970 Source (S4)
- 1884-1900 Source (S2)
- 1893 Source (S3) & (S7)

**Data in Maxau**

- since 1815: stage series
- since 1947: gaugings

Before 1947, reconstructed discharge series by hydraulic studies

**Conversion of raw discharge data into corrected flood data**  
(baseline conditions with a morphological state of the bed river in 1977)  
→ use of hydraulic studies

3

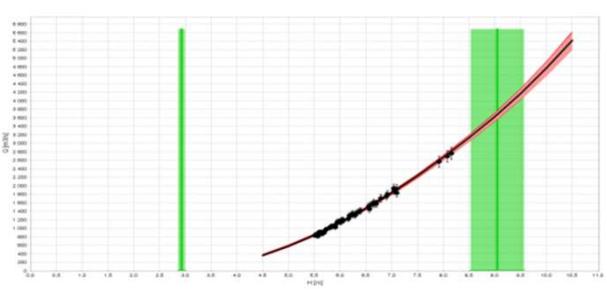
Long series in Basel and Maxau	Uncertainty on flood discharge	Local flood distribution	Hydrological consistency with a regional GEV distribution
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## Use of the BaRatin bayesian model

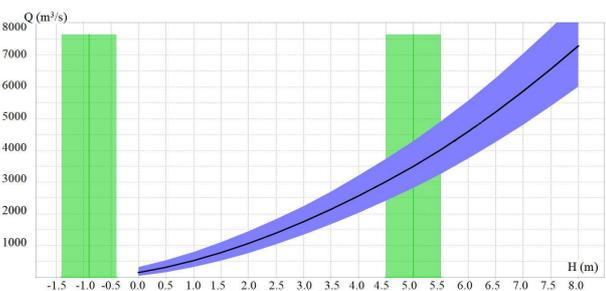
Le Coz *et al.* (2014) J. Hydrology ([doi: 10.1016/j.jhydrol.2013.11.016](https://doi.org/10.1016/j.jhydrol.2013.11.016))

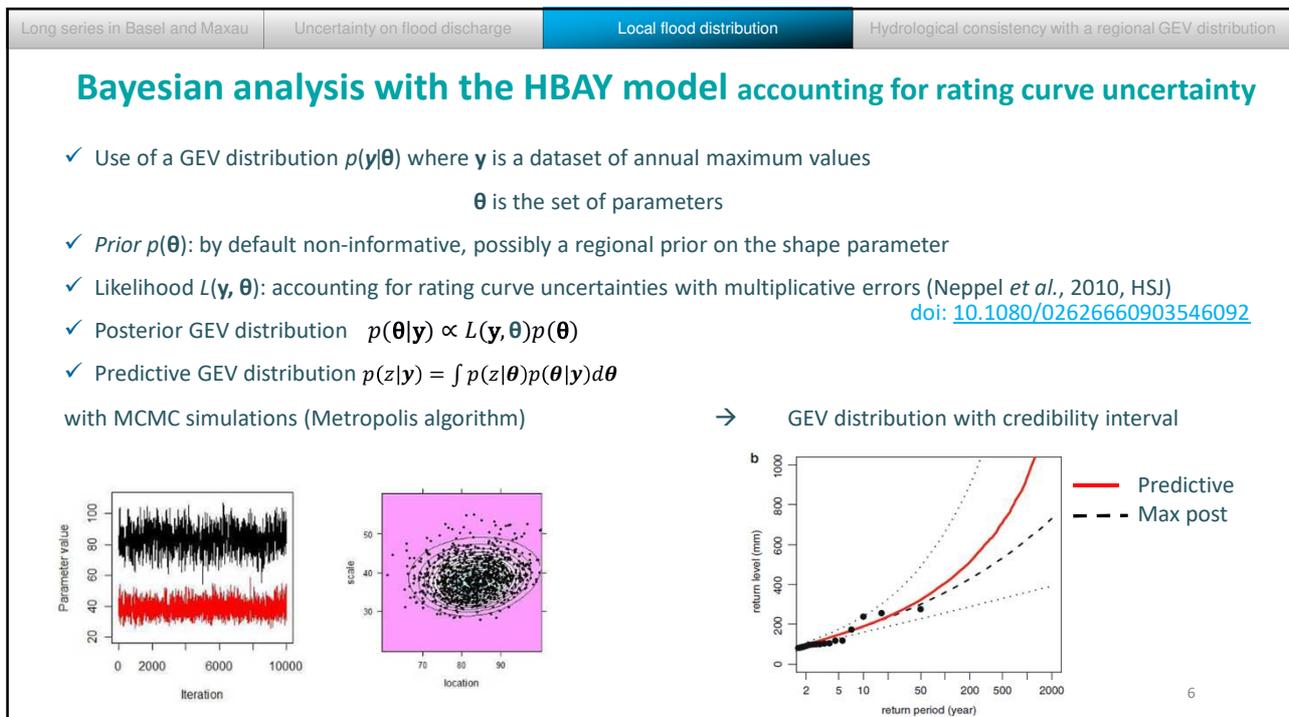
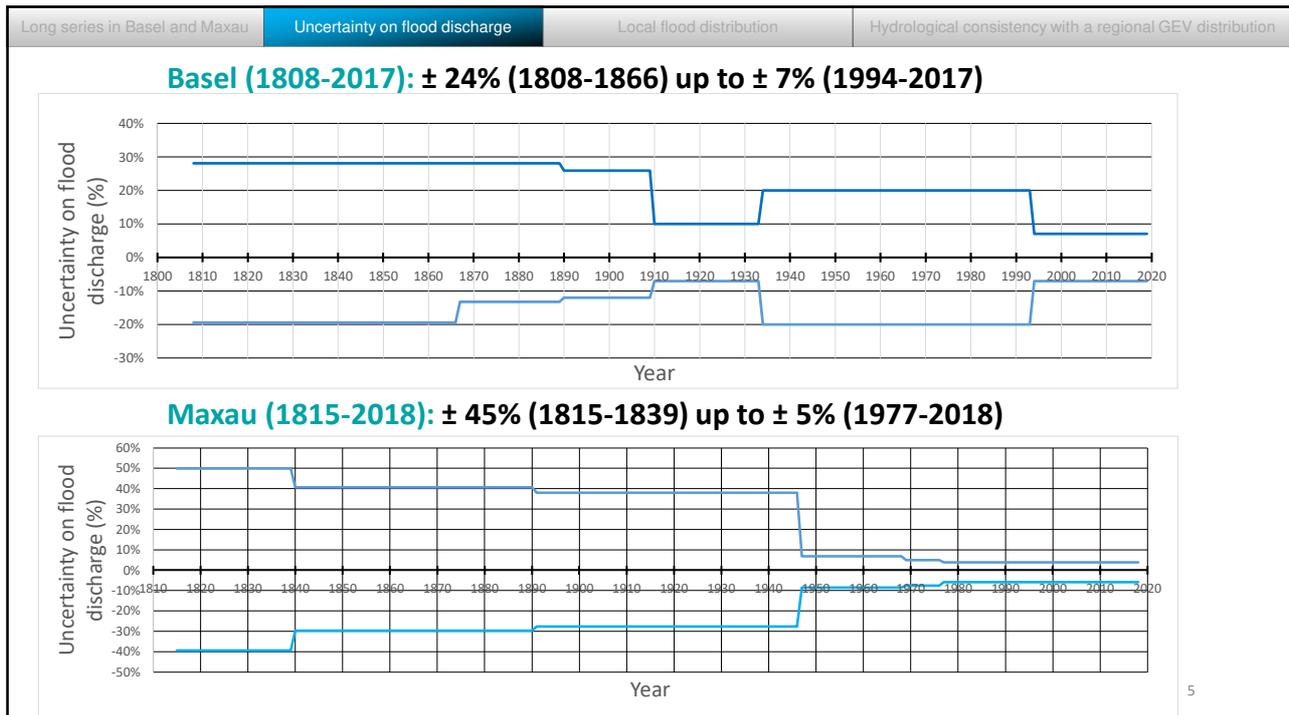
- ✓ Prior on the rating curve parameters from an expertise of the hydraulic controls
- ✓ Use of gauging information *with* associated uncertainties
- ✓ Bayesian combination of the prior + gaugings
- Assessment of the rating curve + uncertainties

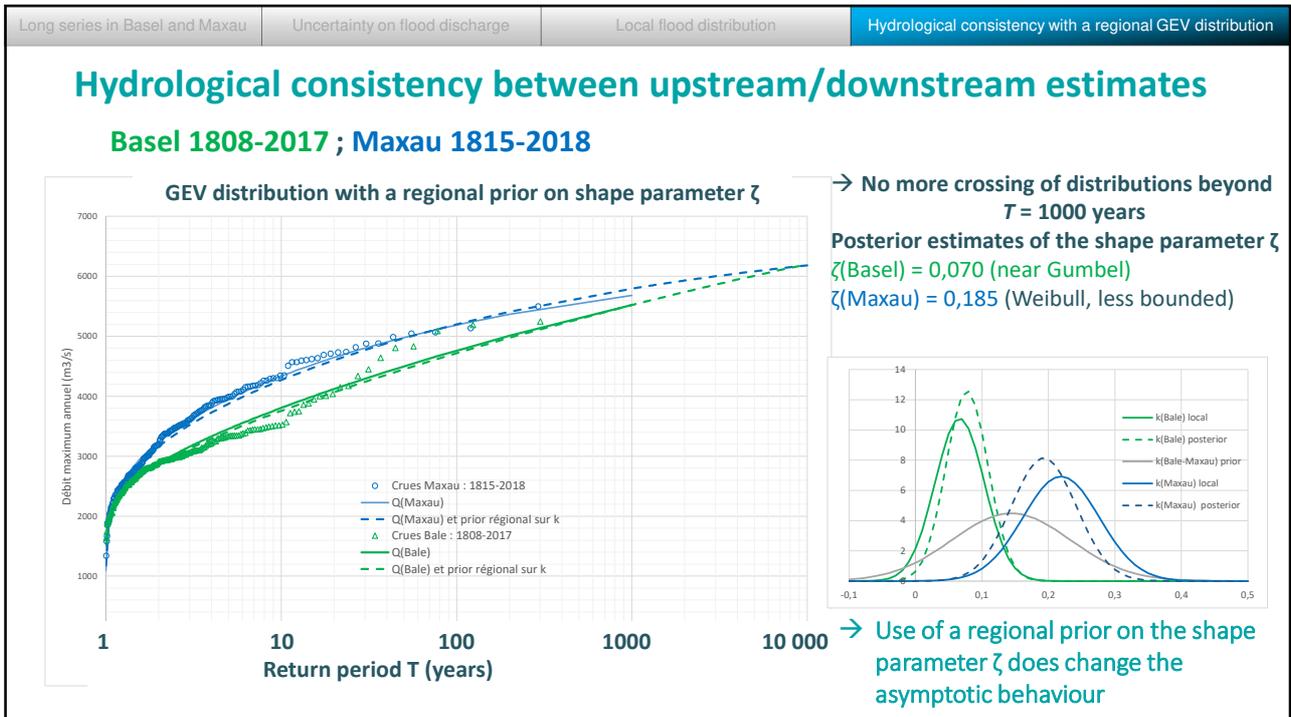
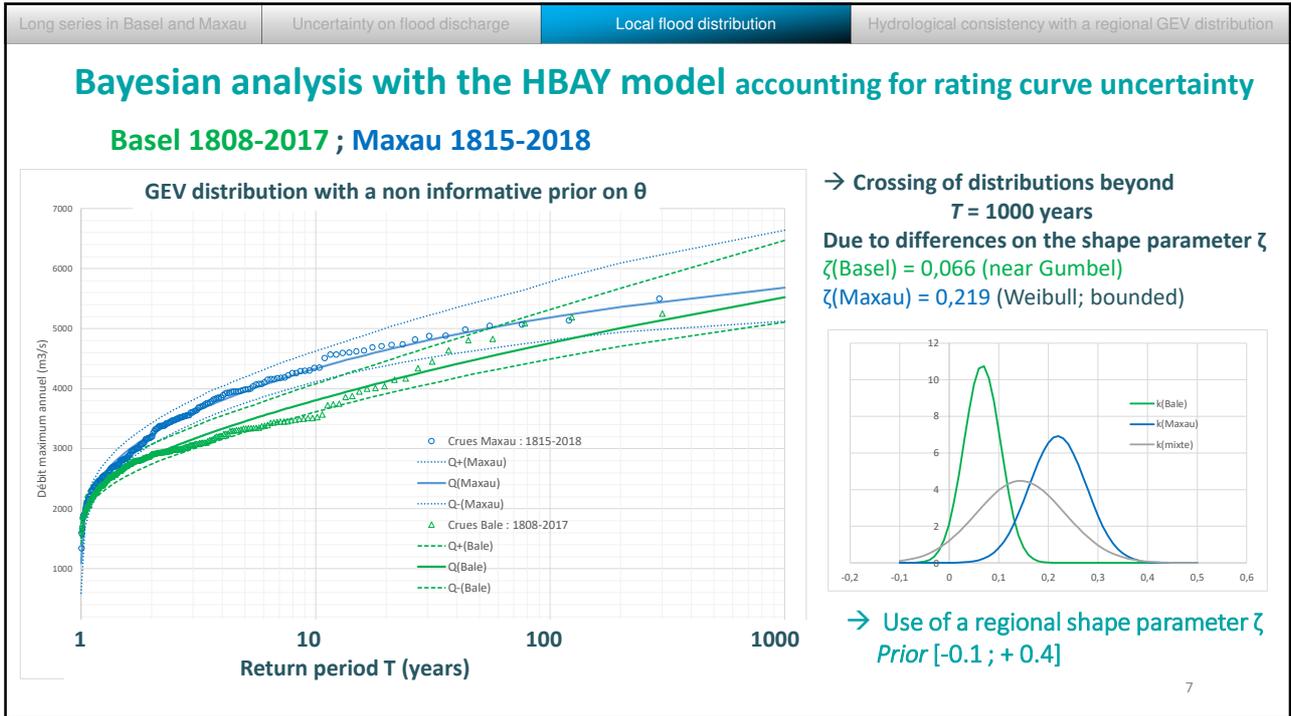
**Basel/ Rheinhalle 1994-2018**  
90 ADCP gaugings (uncertainty ± 5%)

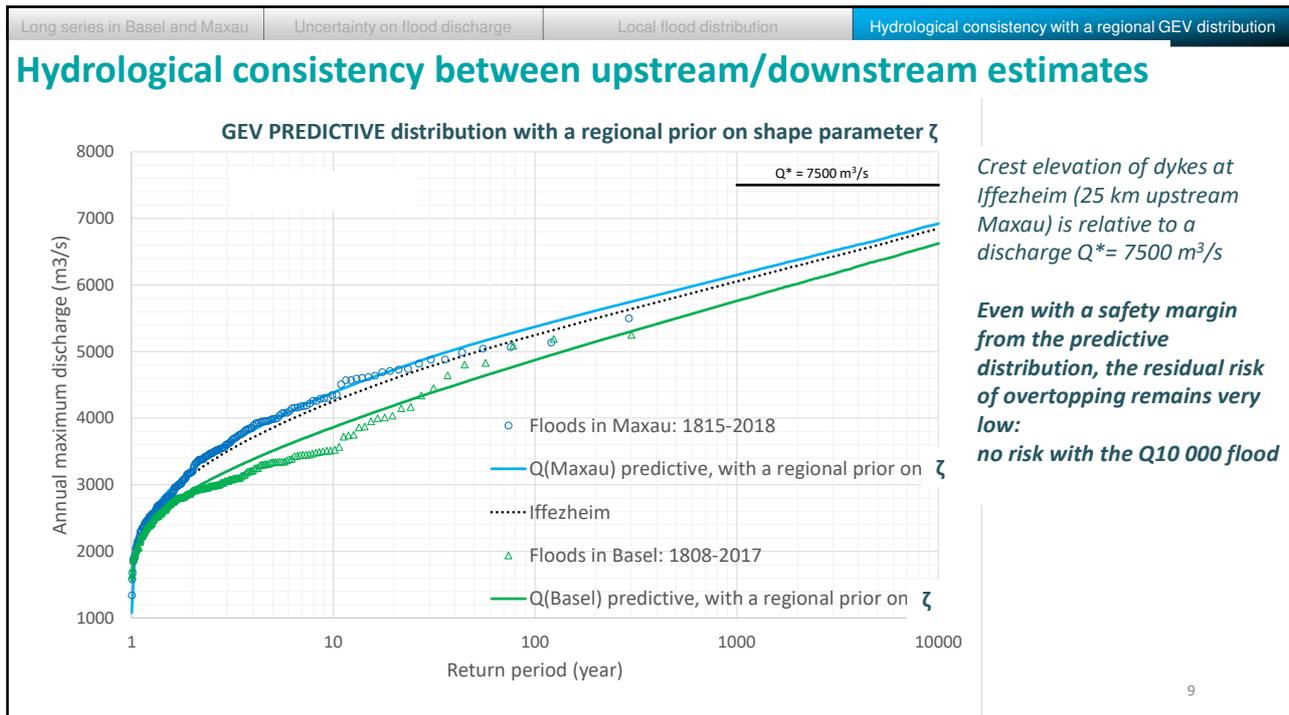


**Basel/ Schiffflände 1808-1866**  
no gauging









## Conclusion

- Long discharge flood series on the upper Rhine (Basel/Maxau) with about 2 centuries of record are a valuable source of data for extreme flood analysis
- A Bayesian analysis allows to account that «modern» flood discharges have lower uncertainties than «historical» flood discharges

**Basel (1808-2017):  $\pm 7\%$  (1994-2017) up to  $\pm 24\%$  (1808-1866)**

**Maxau (1815-2018):  $\pm 5\%$  (1977-2018) up to  $\pm 45\%$  (1815-1839)**

- Hydrological consistency between upstream and downstream estimates of Q1000 flood can be achieved with a regional prior on the shape parameter of the GEV distribution
- Predictive distribution gives the opportunity to account for parameters uncertainty

