Ministerie van Verkeer en Waterstaat

Rijkswaterstaat

Estimating extreme river discharges using generated series and Bayesian method

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Estimating extreme river discharges

- Design discharges and estimating methods
- Why generated series ?
- Computations / results
- Conclusions / recommendations

Design discharges in the Netherlands

- Design discharges are discharges with return periods of 1250 years (frequency of exceedance on average once in 1250 years)
- Design discharges are currently estimated by fitting probability distributions
- Observed annual maximum discharges form the basis for these fitting methods

Fitting distributions

- Classic methods (MM, ML, …)
  - Deterministic values as parameter estimations (exp. ML estimates are values which maximize the L-function)
  - Suitable for large number of observations
  - Goodness of fit test to select an appropriate distribution
  - Only inherent uncertainty (uncertainty in nature)
- Bayesian method (deals also with statistical uncertainties)
  - Parameter uncertainties
    - parameters are considered as random quantities
  - Distribution type uncertainties
    - Bayes weights / combined distribution

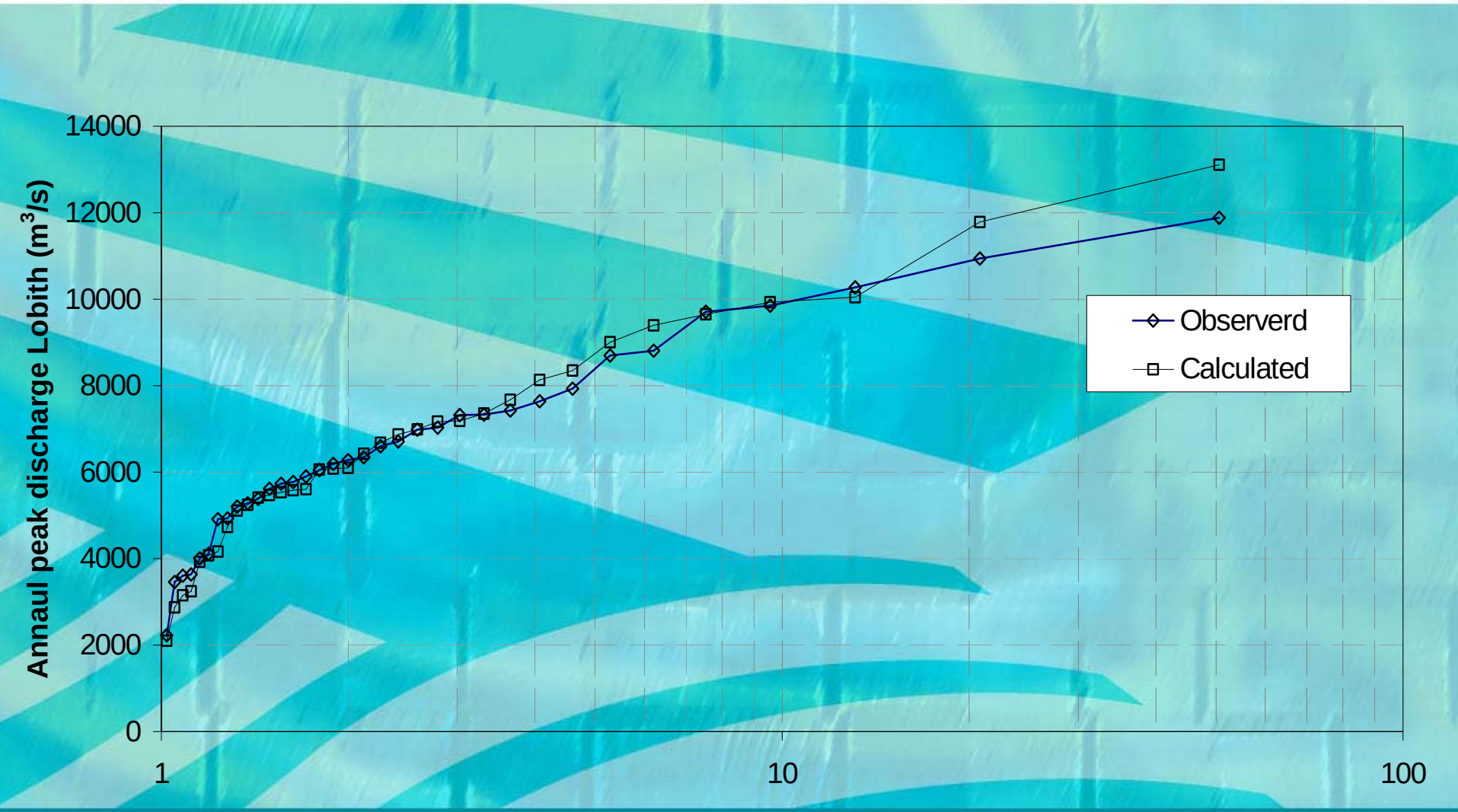
Why generated series ?

- Design discharge have large return periods (1250)
- Observations available for a period of 100 years
- Extrapolation is inevitable (pure statistically)
- Representativeness of 100 years records
- Large statistical uncertainties
- Interests not only in peaks but also in shape and duration of flood
- Genesis of water (physics of the system)
- .....

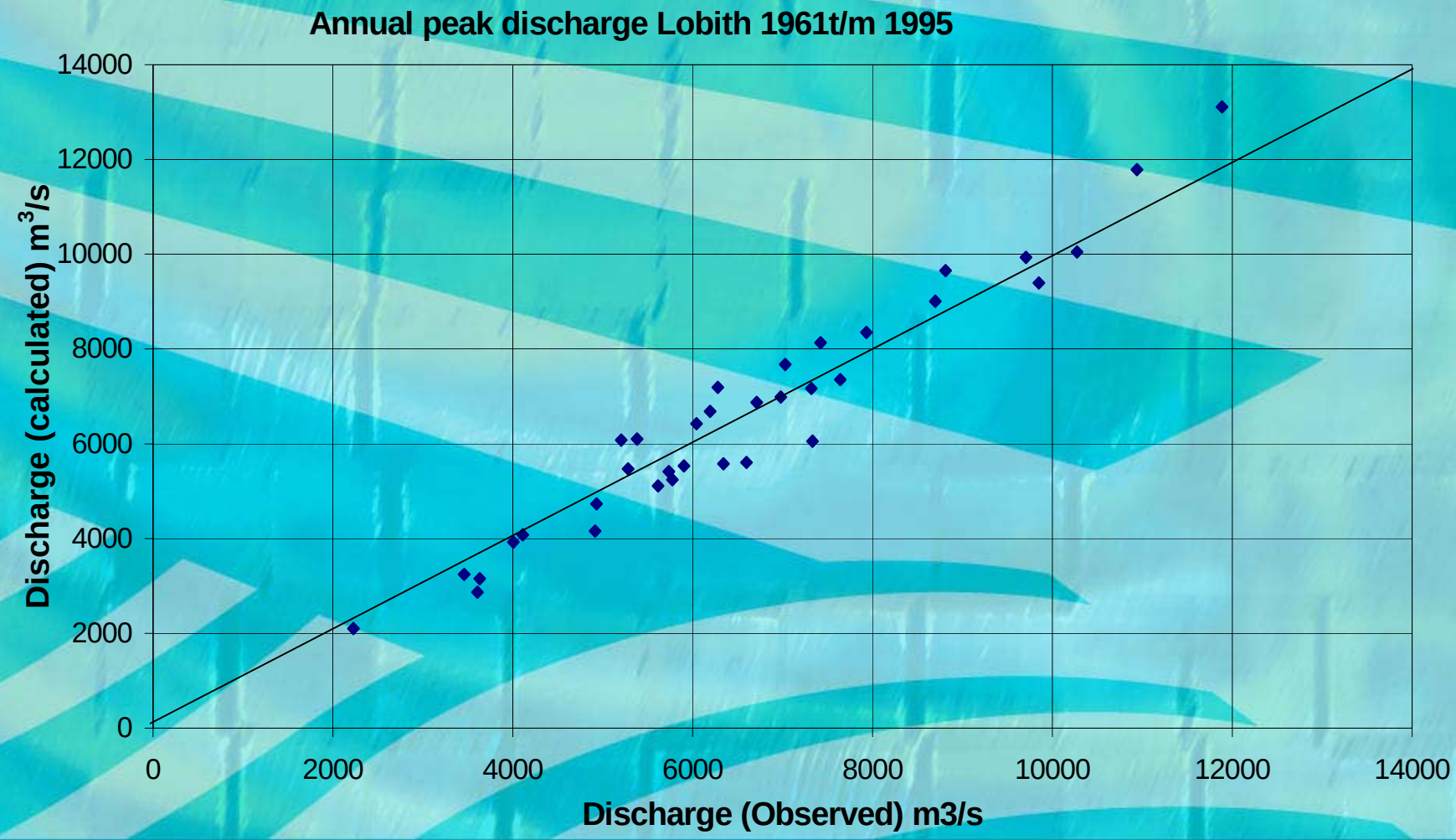
Generated series of discharges

- Stochastic multivariate weather generator
  - Daily rainfall and temperature over the river basin
- Hydrological models
  - Precipitation runoff models for the major river tributaries
- Hydrodynamic model
  - Routing runoff from hydrological models

Observed and generated discharges in the period 1961-1995



Observed and generated discharges in the period 1961-1995



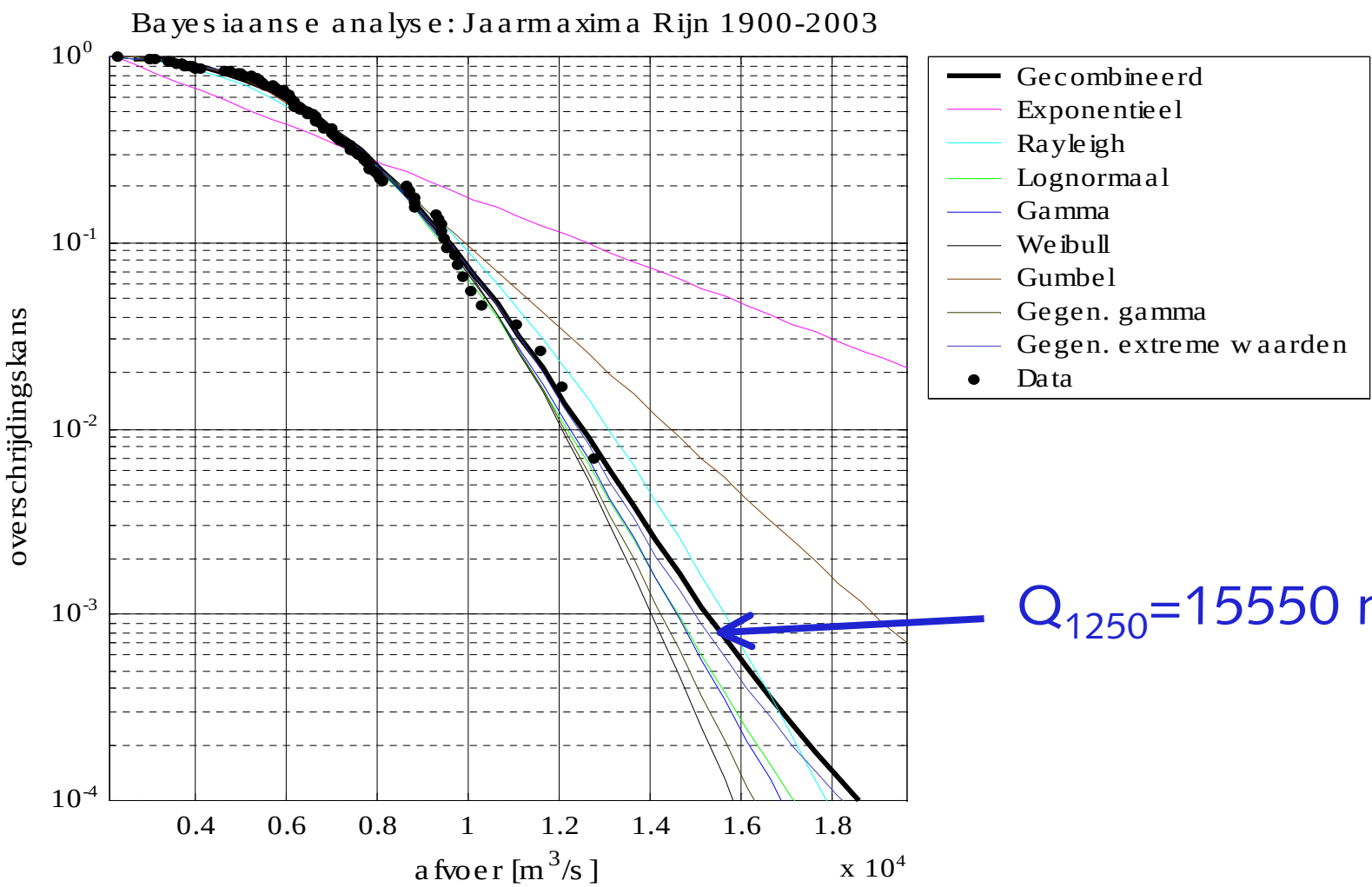
Computations

- Annual maximum discharges of the Rhine at Lobith in the period 1901-2002
- Generated series for a period a period of 1000 years (at Lobith)
- 8 distributions functions studied: exponential, Rayleigh, lognormal, gamma, Weibull, gumbel, generalised gamma and generalised extreme value (GEV)
- Maximum likelihood and Bayesian method used

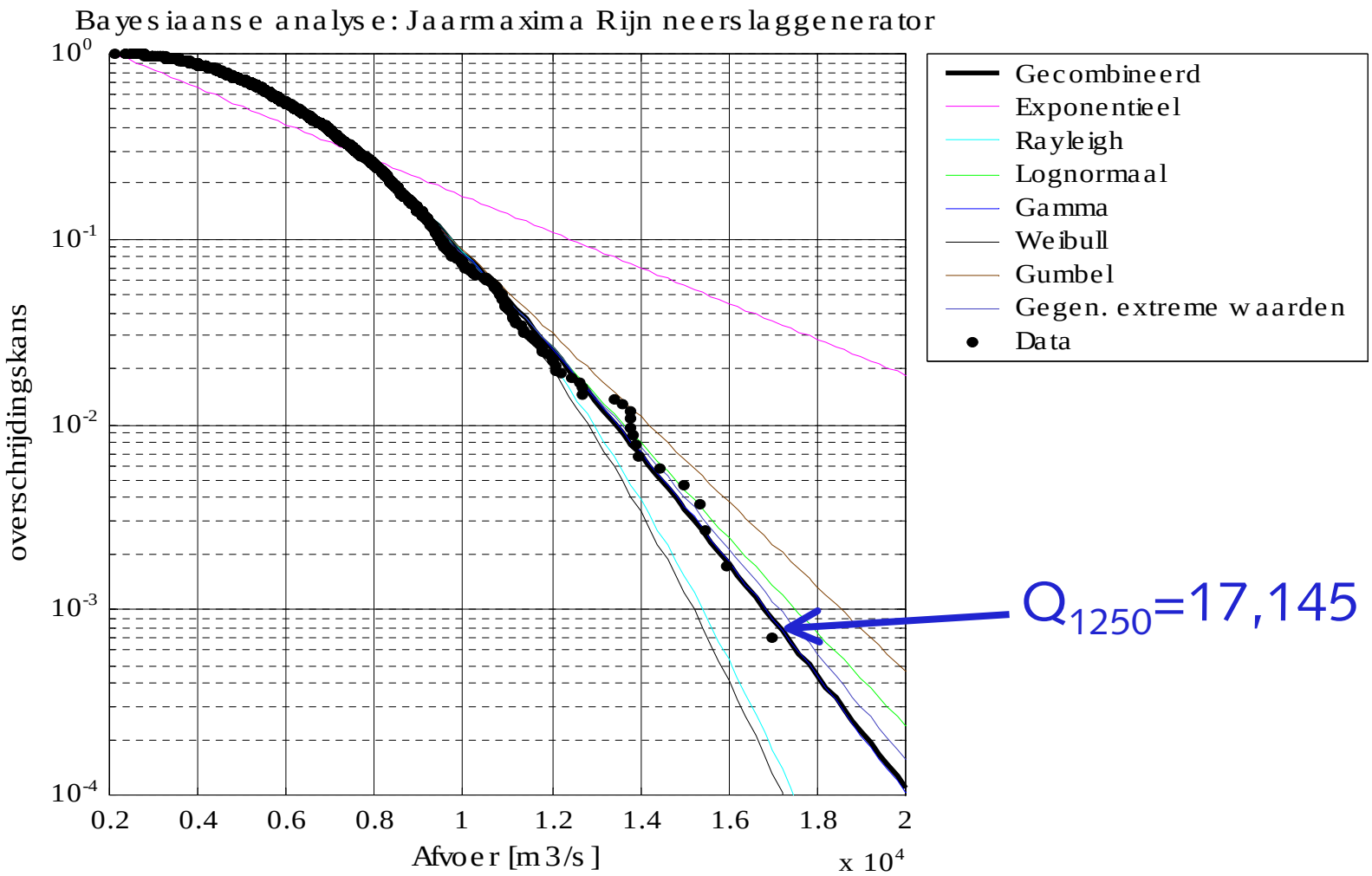
Results of computations

- ML-method and observed annual maximum discharges from the period 1901-2002
  - 7 distributions could principally not be rejected
- ML-method and Generated annual maximum discharges for a period 0f 1000 years
  - 4 distributions could principally not be rejected
- Bayesian method and observed annual maximum discharges from the period 1901-2002
  - Weibull and Rayleigh with Bayes weights of 23 and 18 % resp.
  - Design discharge = 15,550 m3/s
- Bayesian method and generated annual maximum discharges for a period of 1000 years
  - Gamma: with Bayes weight of 80 %
  - Design discharge = 17,140 m3/s

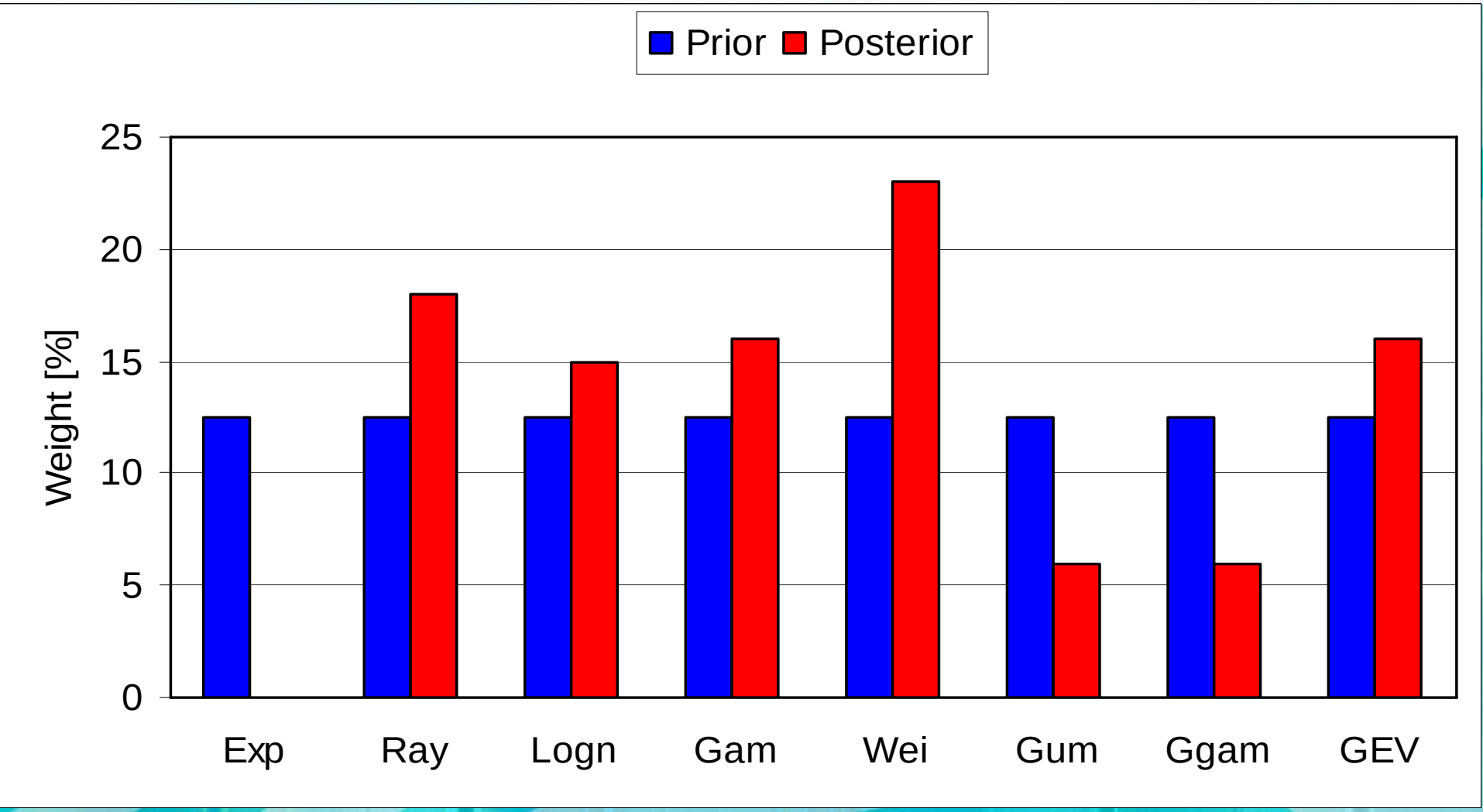
Bayesian fit, observations



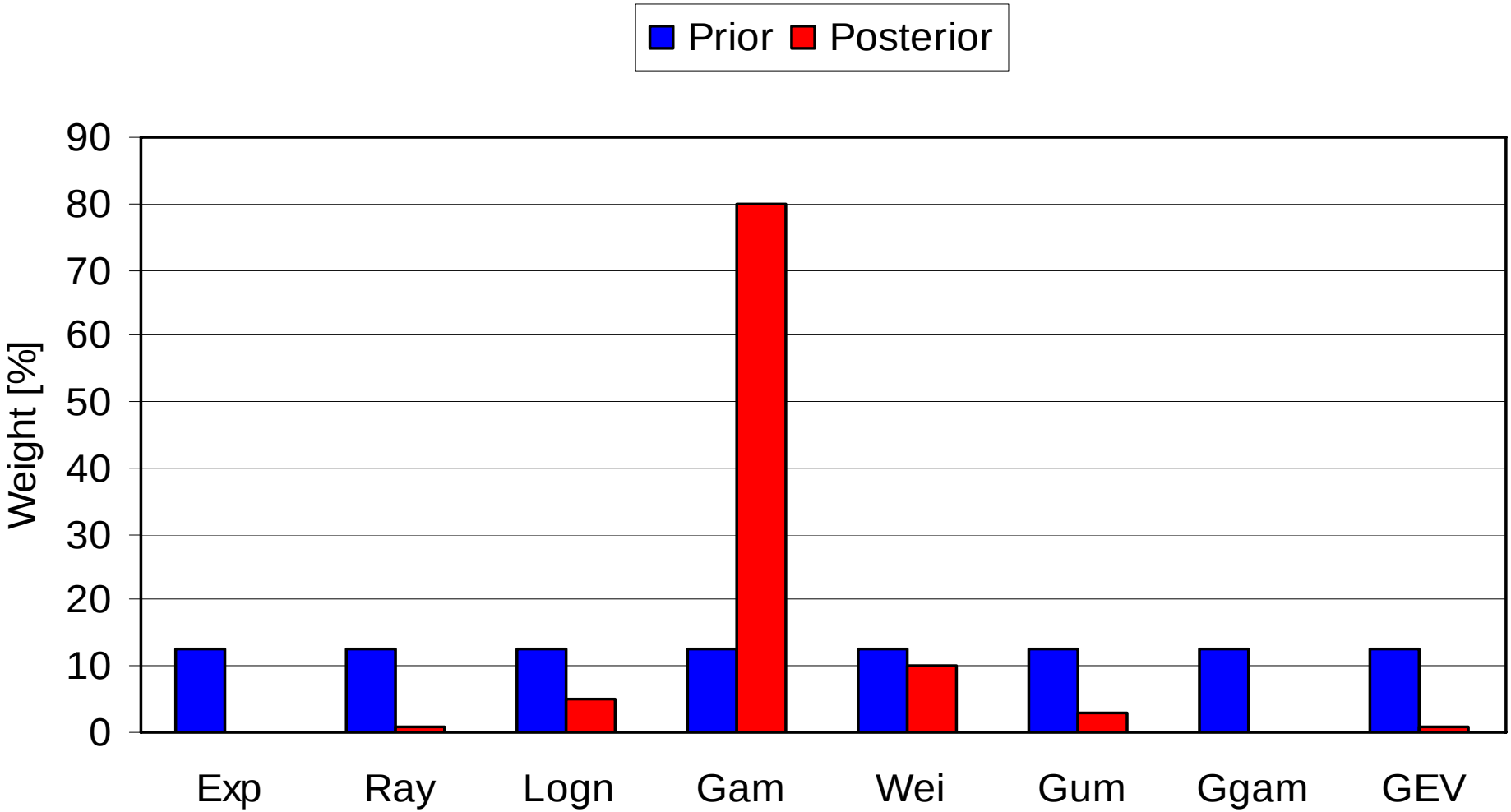
Bayesian fit, generated series



Prior and posterior weights: observed discharges from the period 1901-2002



Prior and posterior weights generated discharges for a period of 1000 years



Conclusions

- ML and generated series: rejection of more distributions,
- Observations: meagre Bayes weights (Wei and Ray),
- Generated series: excellent fit with higher Bayes weights corresponding to Gamma
- Bayes weights and calculated 1/1250 discharges are incoherent,
- Observed and generated series **seem** (?) to be not identically distributed
- But …

Discussion / recommendation

- Extreme discharges (> 13000 m^3/s) are not occurred yet (not in observed series),
- Flooding abroad has (temporarily) not been considered (not in generated generated series)
- It's early days yet (to say anything useful about whether the two series are identically distributed)
- Flooding abroad must be taken into account