Sample Uncertainty Analysis of Daily Flood Quantiles Using a Weather Generator

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1. INTRODUCTION

The problem: short length of available observations.

Synthetic Continuous Simulation:

Stochastic **Weather Generator (WG)** + **Hydrological model (HM)**:
Stochastic generation of continuous synthetic precipitation (P) series and stochastic generation of continuous synthetic discharges (Q).

❖ Pros:
- Continuous long series of meteorological data with similar statistical properties as those of observed data → Initial soil moisture content
- Parametric WG → different weather scenarios can be simulated
- Multi-site WG → spatio-temporal variability

❖ Cons:
- Adequacy of the meteorological model
- If sub-daily → complexity and high computational requirements
- Adequacy of hydrological model

Extreme rainfall regime complicates even more Flood Frequency Estimation of high Return Period flood quantiles X_T

Still difficult to obtain reliable quantile estimates: **HIGH UNCERTAINTY**

Additional information is needed (e.g., regional precipitation studies)

2. SYNTHETIC CASE STUDY

Nine Synthetic populations: Mediterranean Semi-arid, Humid and Extremely Humid climate according to De Martonne Aridity Index (I_a)[1], each one with three different climate extremality ($\xi = 0.05$; $\xi = 0.11$; $\xi = 0.25$).

Variable	Statistic	MEDITERRANEAN SEMI-ARID ($\bar{I_a}$=21,6)			HUMID ($\bar{I_a}$=33,8)			EXTREMELY HUMID ($\bar{I_a}$=59,4)			
		ξ = 0.05	ξ = 0.11	ξ = 0.25	ξ = 0.05	ξ = 0.11	ξ = 0.25	ξ = 0.05	ξ = 0.11	ξ = 0.25	Units
Daily P	% $D_p > 0$	24.79	24.79	24.79	31.11	31.34	31.91	57.95	57.95	57.95	%
Annual P	Mean	572.46	572.62	569.76	748.94	748.91	748.23	1313.27	1315.27	1313.08	mm
Annual max Daily P	Mean	59.56	62.96	70.77	47.61	50.88	60.88	53.51	58.07	72.18	mm
	CV	0.43	0.48	0.67	0.33	0.39	0.60	0.31	0.36	0.57	-
	Coeff. Skewness	1.55	2.02	3.53	1.36	1.75	4.53	1.41	1.81	3.63	-
	Coeff. Kurtosis	7.25	10.68	27.61	6.25	8.62	52.26	6.91	9.54	30.82	-

For the sake of simplicity, basin characteristics are obtained from an existing study. Drainage area: 180 km^2 approx.
Two different hydrological characteristics of the basin were analyzed, reproducing an ephemeral and a permanent regime.

- **Ephemeral** regime (70% overland flow, 30% interflow, **0% base flow**)
- **Permanent** regime(30% overland flow, 40% interflow, **30% base flow**)

Results for permanent regime are not shown since non-significant changes were detected.

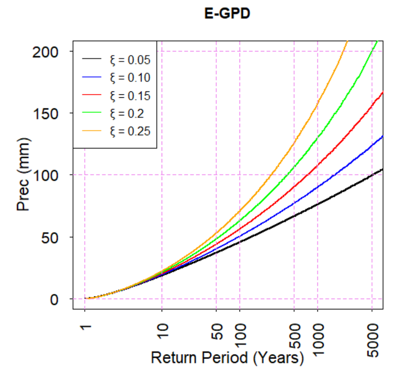
3. METHODOLOGY

GWEX [2]

- **Multi-site** WG of **daily** P and max and min Temp, **focused on extreme events**
- Precipitation amounts: Extended Generalized Pareto Distribution (**E-GPD**)[3]

$$F(x;\lambda) = \left[1 - \left(1 + \frac{\xi x}{\sigma}\right)^{-1/\xi}\right]^{\kappa}$$

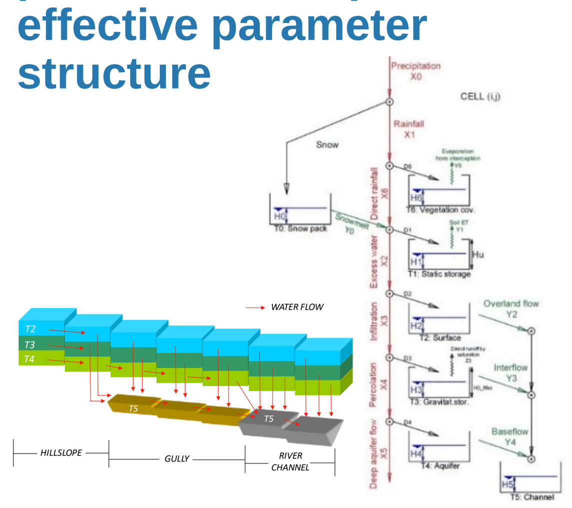
σ → Scale Parameter
κ → Transf. Parameter
ξ → Shape Parameter (directly affecting the upper tail)

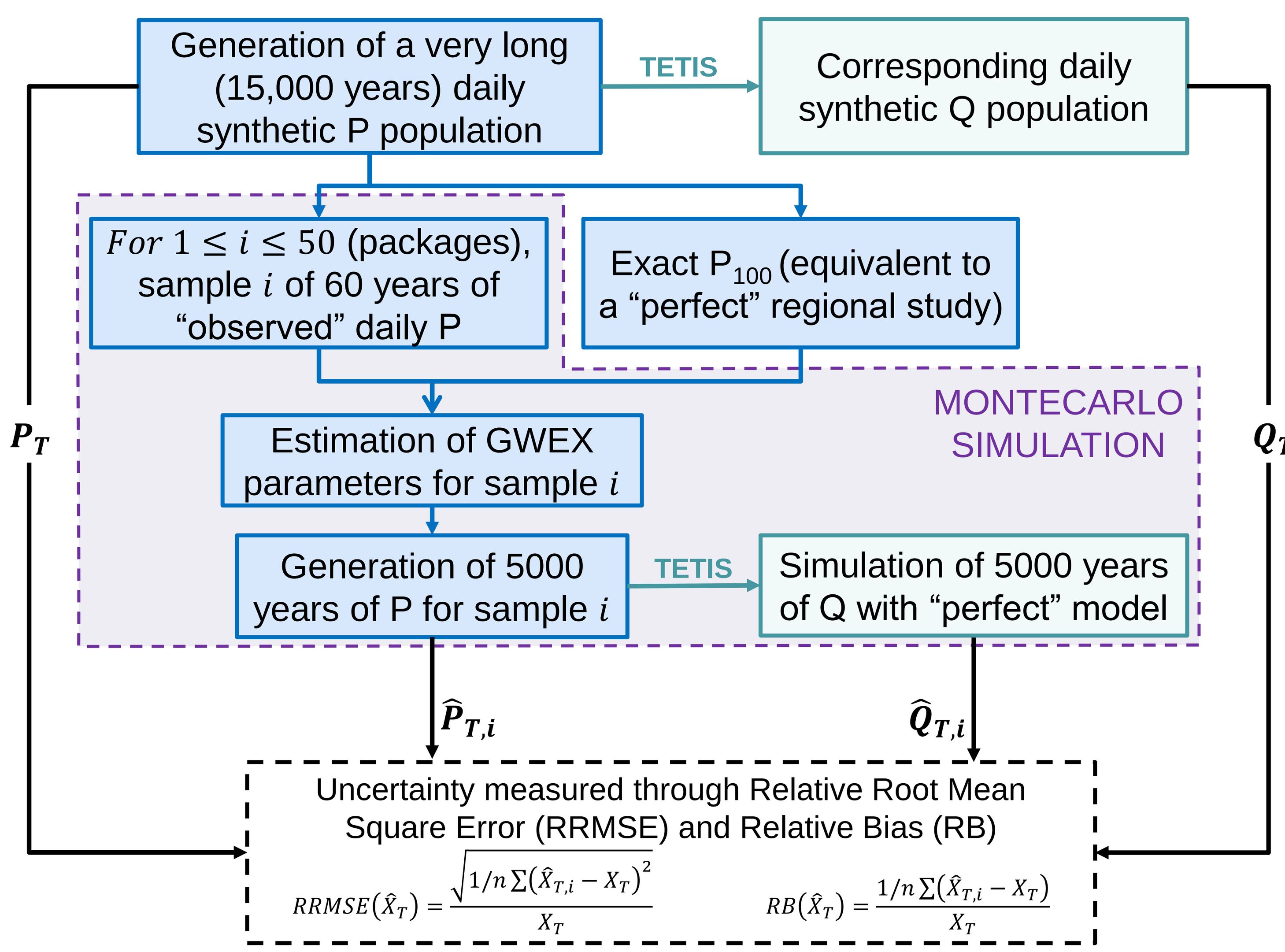


Parameter **ξ** is **estimated with the regional P_{100}**

TETIS [4]

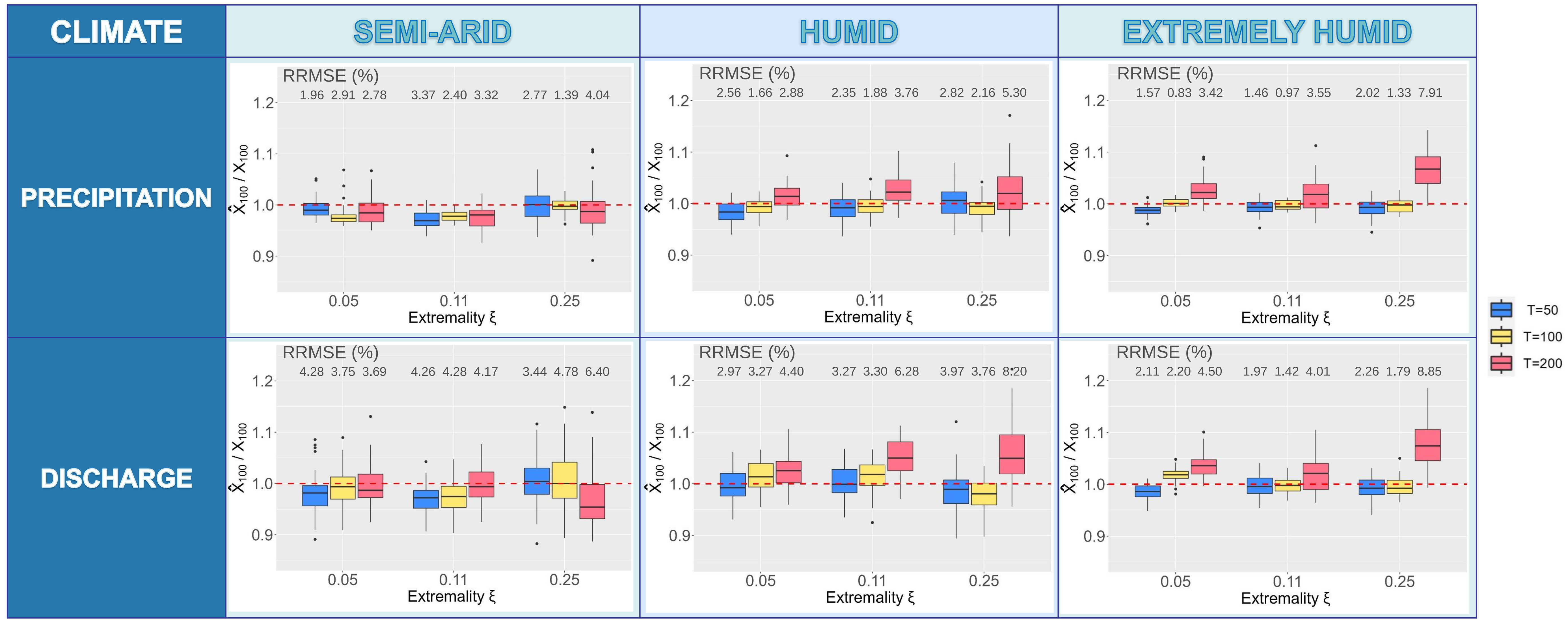
- **Integral** HM
- **Conceptual** (tank structure) model with **physically based parameters**
- **Distributed** in space
- Incorporates a **parsimonious split effective parameter structure**





$$RRMSE(\hat{X}_T) = \frac{\sqrt{1/n \sum (\hat{X}_{T,i} - X_T)^2}}{X_T} \qquad RB(\hat{X}_T) = \frac{1/n \sum (\hat{X}_{T,i} - X_T)}{X_T}$$

4. RESULTS



Different quantile estimates X_T → As expected, quantiles around X_{100} are less uncertain. Underestimation of lower X_T, overestimation of higher X_T, except for semi-arid climate

Different extremalities ξ → As climate extremality increases, uncertainty increase. Lower sensitivity to climate extremality changes in humid and very humid climates.

Different precipitation regimes (3 climates) → Semi-arid climate more uncertain respect to humid and very humid climates in lower T, less uncertain for high T.

From WG to HM → Uncertainty transmitted to the HM, which makes it increase, especially in semi-arid climate.

5. CONCLUSIONS

- As obtained in preliminary studies [5-6], additional information is needed to reduce the uncertainty of P and Q.
- Climate extremality has been demonstrated to be a key factor for the WG performance. As ξ increases, there is more uncertainty on the quantile estimates, especially in those associated with high T.
- For Mediterranean semi-arid climates, where the precipitation regime is less homogeneous, uncertainty of the quantile estimations is clearly higher compared to Humid and Very Humid climates. Quantile estimations in these climates present less uncertainty.
- Uncertainty propagates through Hydrological Model, being this propagation lower in the case of Very Humid climate.

6. REFERENCES

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7. ACKNOWLEDGEMENTS

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