FACETS OF UNCERTAINTY
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The value of uncertainty in practice: Hydrologic design in a river section

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- Models: Cost-benefit analysis and Flood Frequency Analysis
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- Results
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Flood Frequency Analysis and Uncertainty

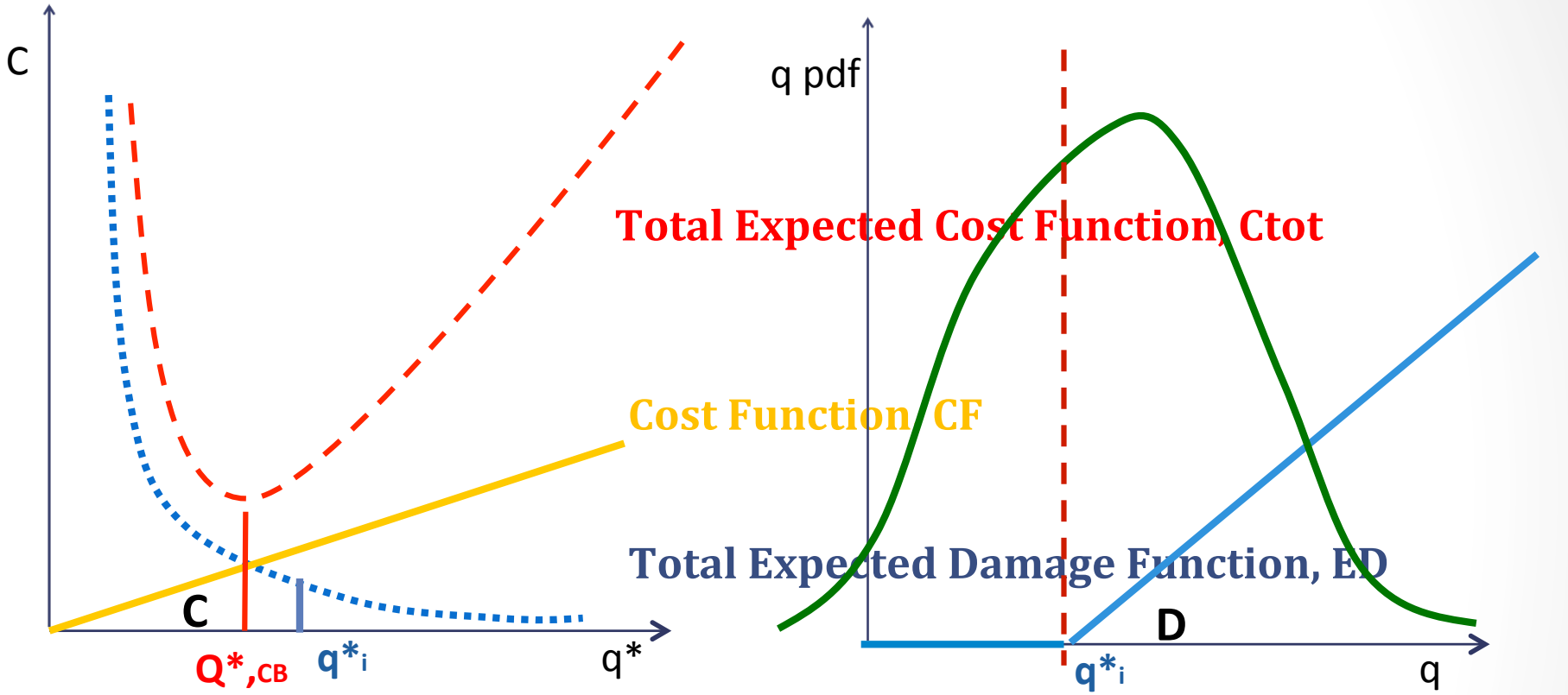
Flood Frequency Analysis → Design Flood Estimator **but….**

Flood Frequency Analysis is an UNCERTAIN procedure

Aim: calculate a **Design flood estimator** where **UNCERTAINTY** is taken into account

1. **Parameter** estimation
2. **Data** (sample length)

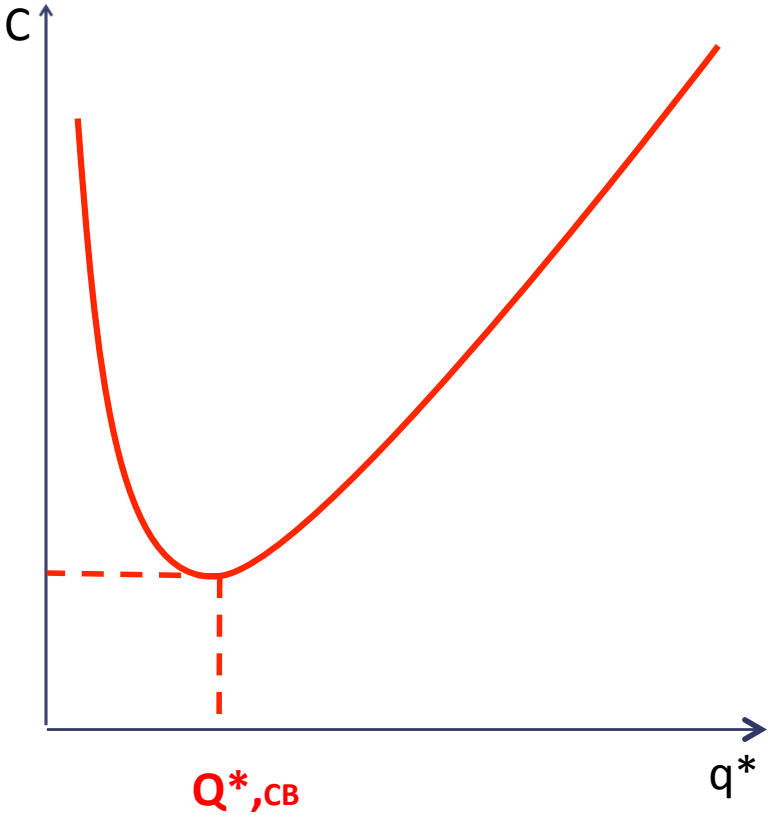
Cost-Benefit Analysis

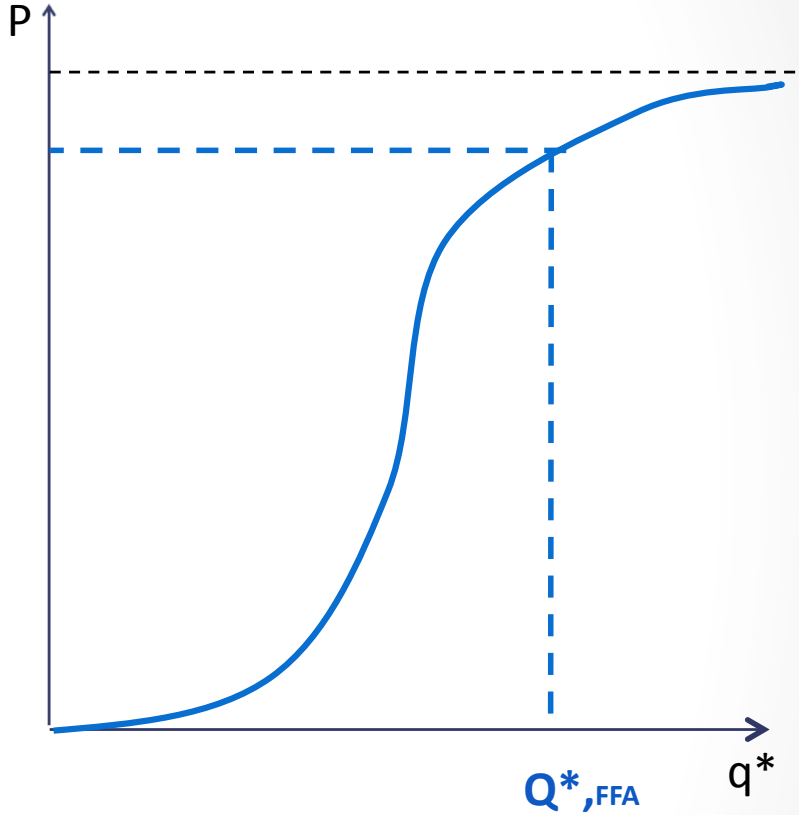


$$C_{TOT}\left(q^* \mid \mathbb{C}, \mathbb{D}, \Theta\right) = CF\left(q^* \mid \mathbb{C}\right) + \int_{q^*}^{\infty} \Delta\left(q^*, q \mid \mathbb{D}\right) \cdot p\left(q \mid \Theta\right) \mathrm{d}q$$

The design flood which corresponds to the minimum of total expected cost is the **DESIGN FLOOD ESTIMATOR** obtained from the Cost-Benefit Analysis.

Cost-Benefit Analysis and Flood Frequency Analysis





Analytically, it can be demonstrated that $Q^*_{CB} = Q^*_{FFA}$

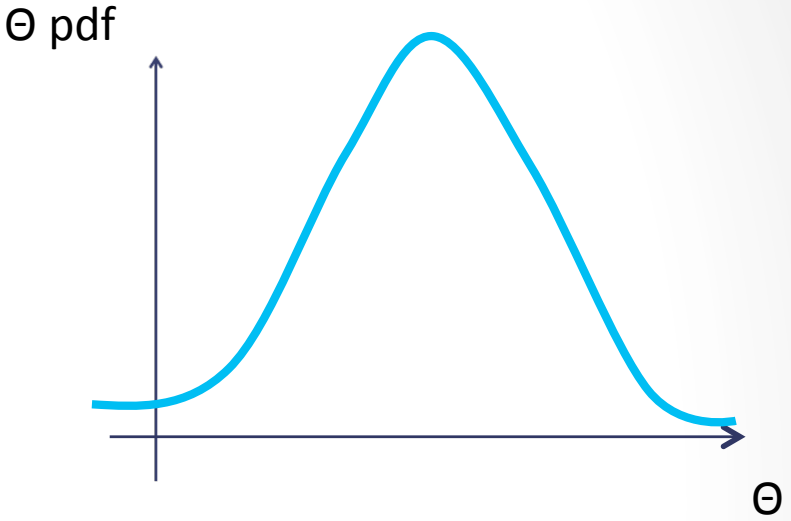
when **Cost and Damage function are LINEAR**

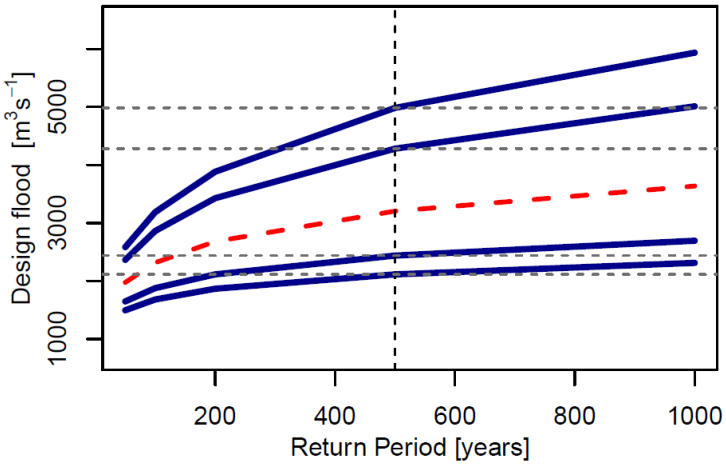
and $D/C = T$

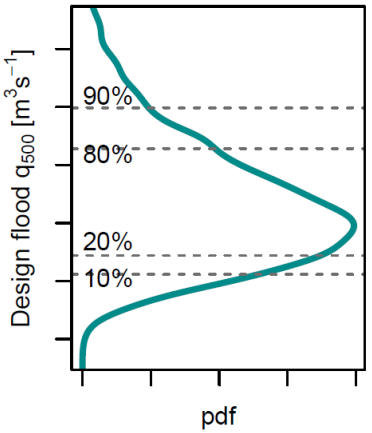
Design Flood Estimation and Parametric Uncertainty

Parameters Θ are **RANDOM variables**, so…

…they can be represented by a **Multivariate Probability Distribution Function**



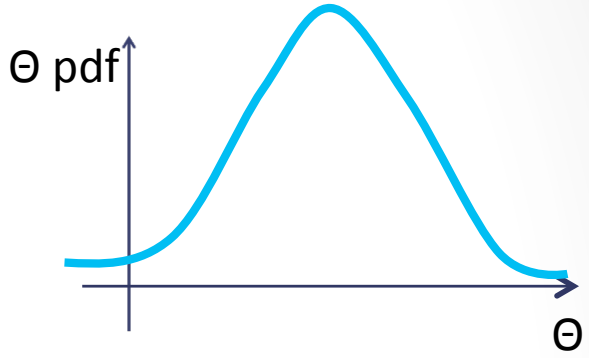


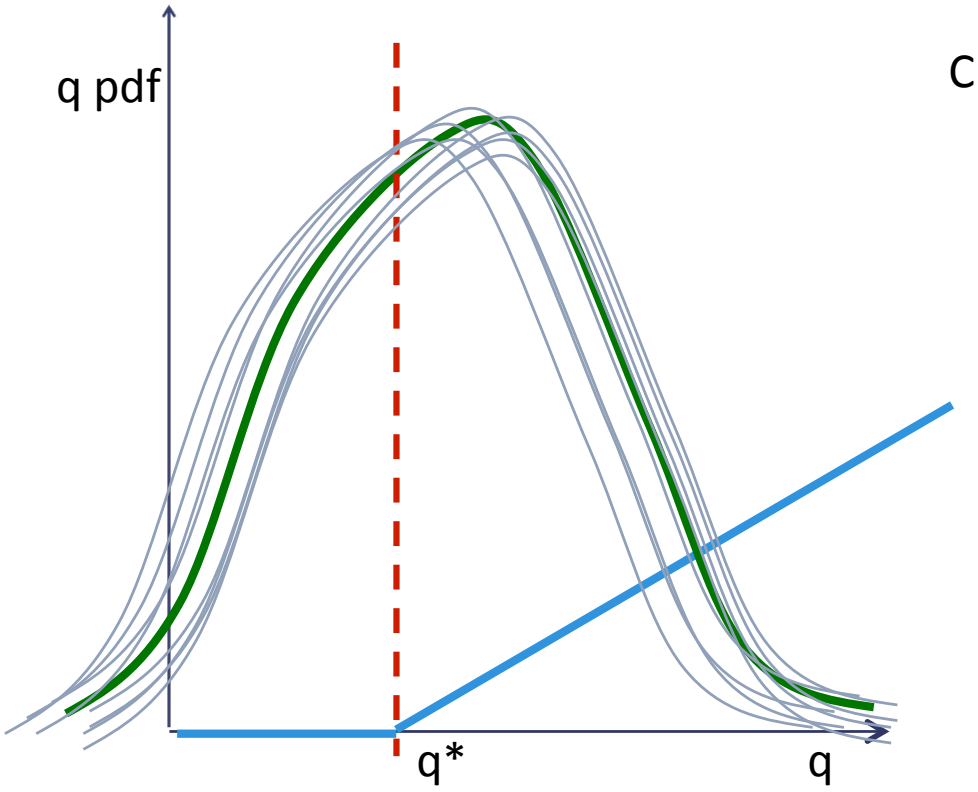


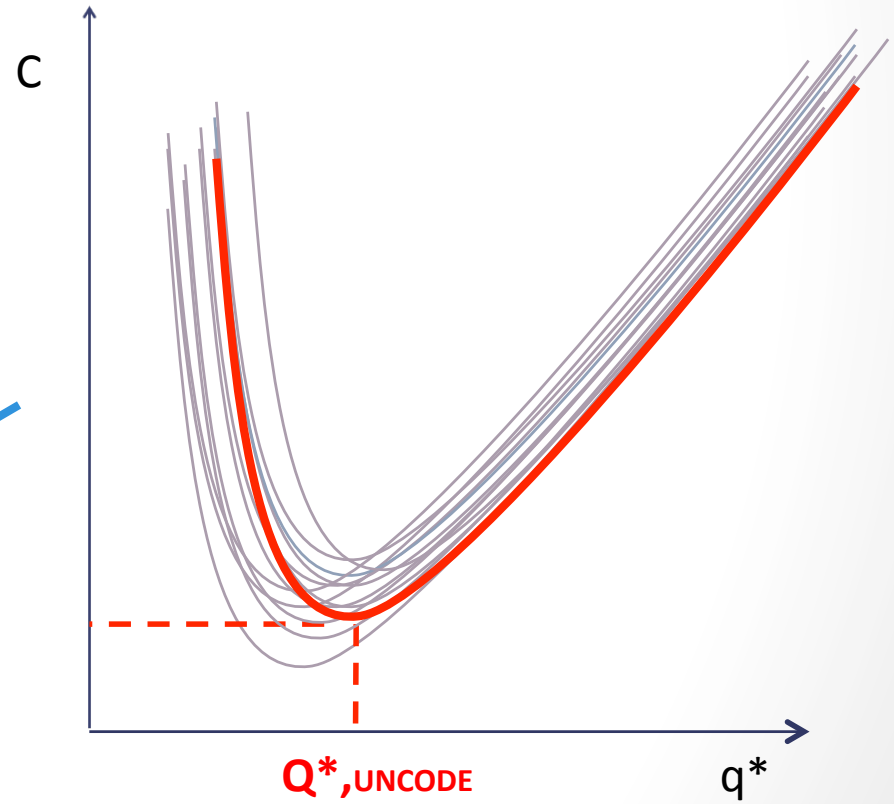
If parameters are random variables, **Confidence bands** of the Design Flood Estimators can be obtained

Cost-Benefit Analysis and parametric uncertainty the **UNCODE** (UNcertainty-COmpliant DEsign)Procedure

Parameters Θ are **RANDOM variables**, so…



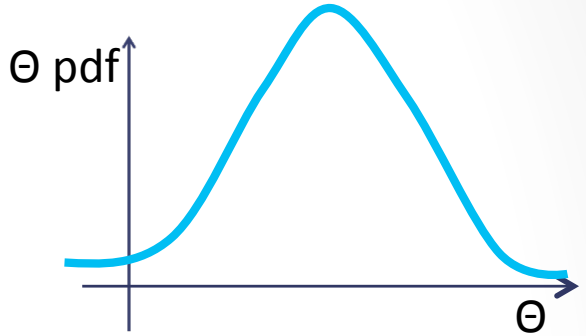


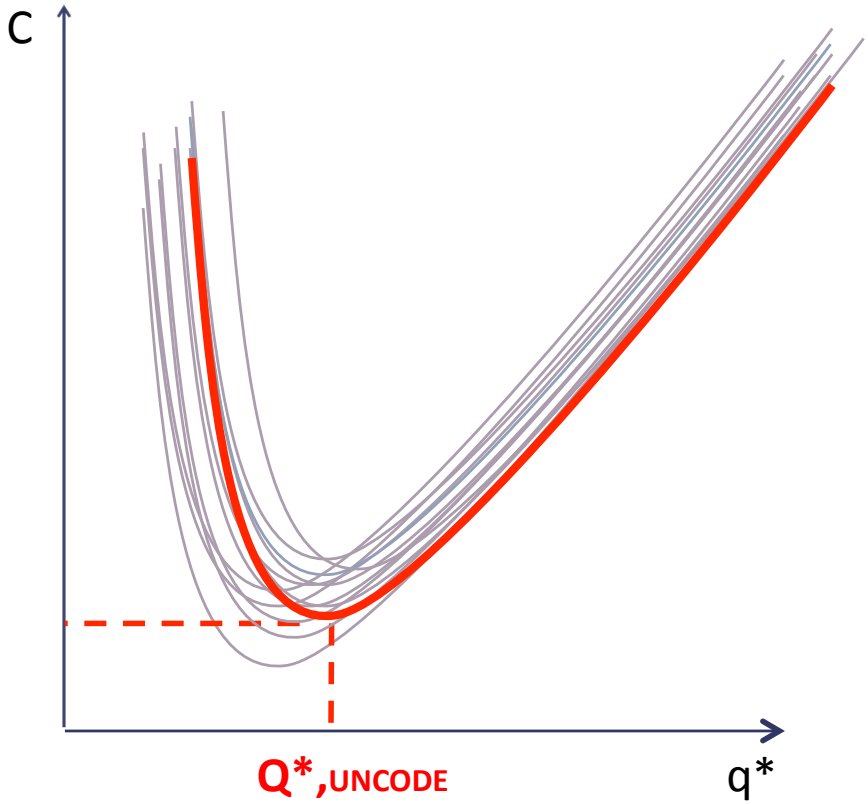


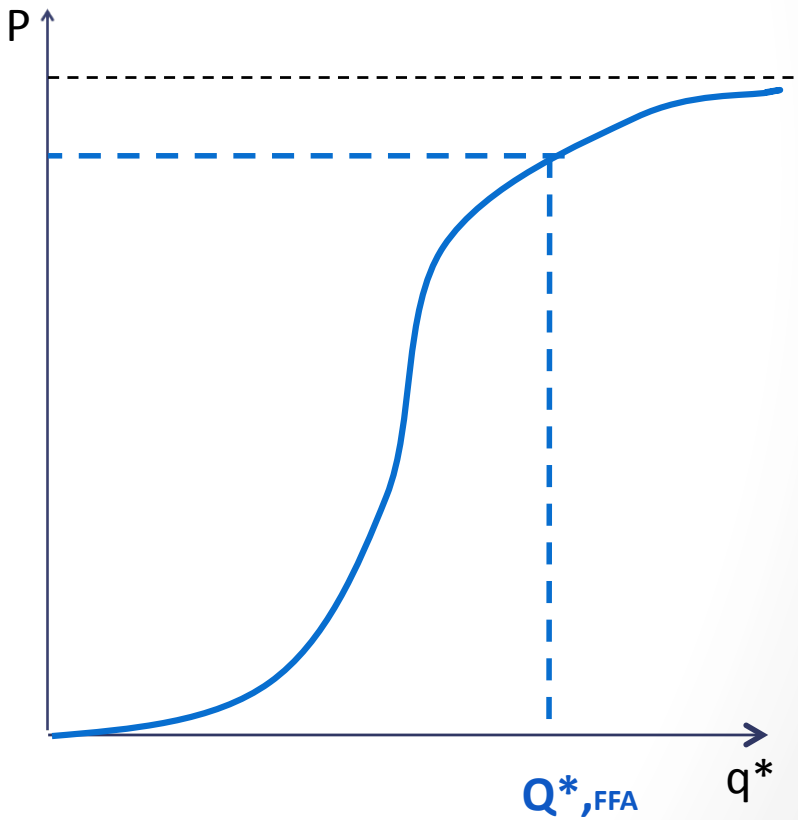
UNCERTAINTY+MODELS

Cost-Benefit Analysis and parametric uncertainty the **UNCODE** (UNcertainty-COmpliant DEsign)Procedure

Parameters Θ are **RANDOM variables**, so…

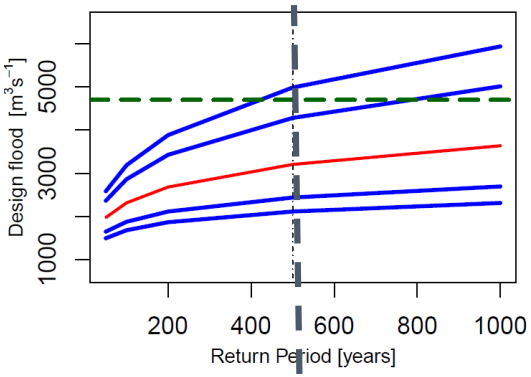


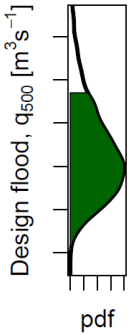




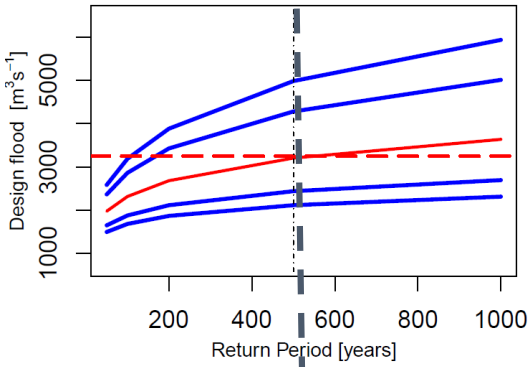
$Q^{*,UNCODE} \neq Q^{*,FFA}$

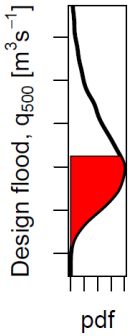
Design Flood Estimation and parametric uncertainty



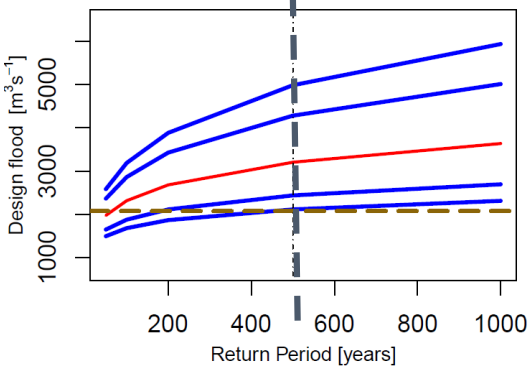


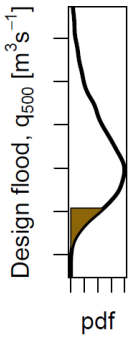
CP > 0.5 → γ > 0 [Under-estimation]





CP = 0.5 → γ = 0

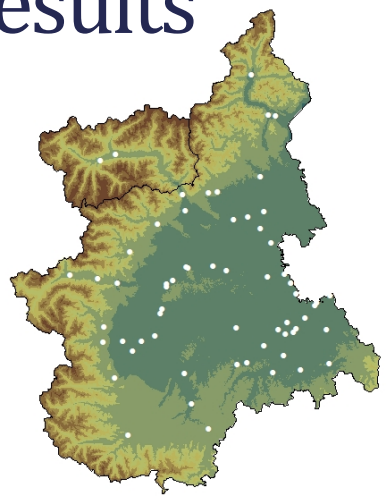




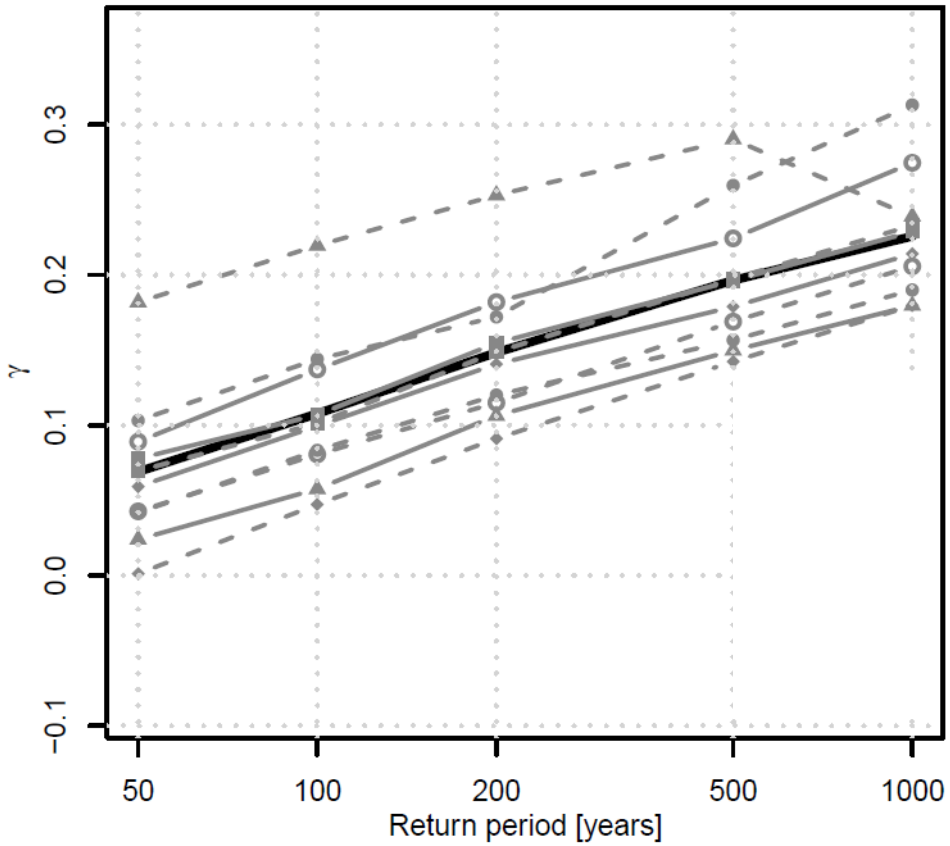
CP < 0.5 → γ < 0 [Over-estimation]

UNCERTAINTY+MODELS

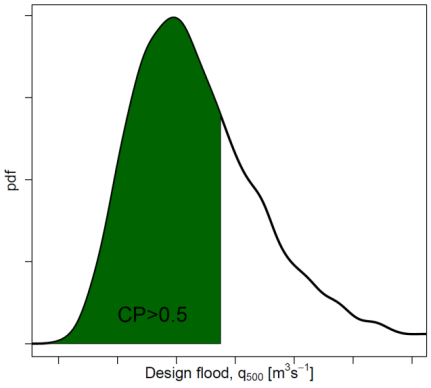
Results



The UNCODE Method has been applied in cross sections in Piemonte and Valle d'Aosta, North-West Italy



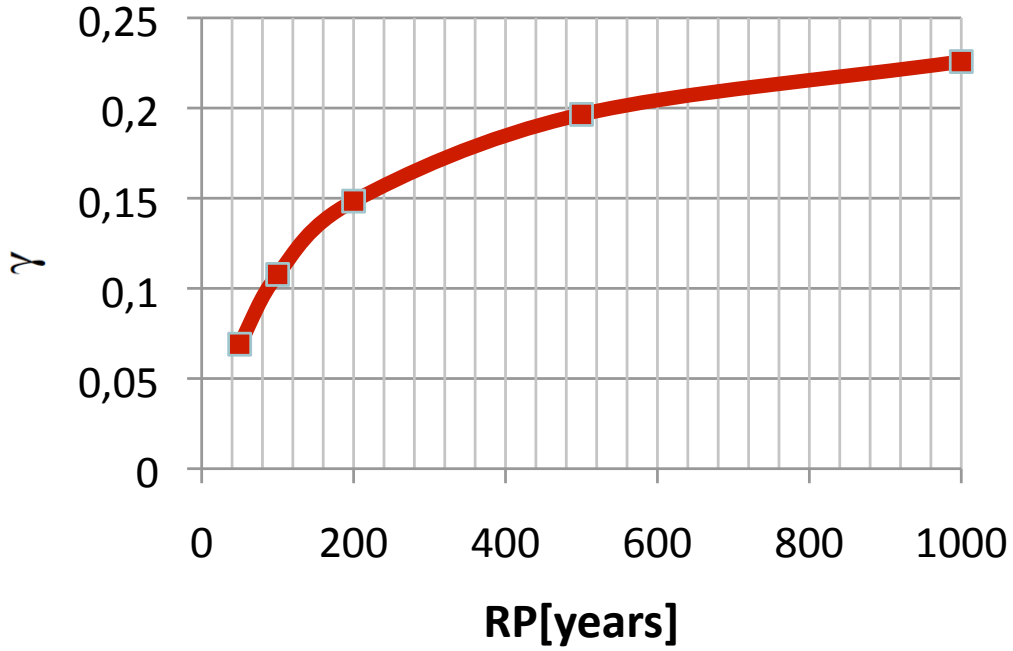
γ > 0



Standard Design Flood Estimators ($\gamma = 0$) seems to be under-estimated when uncertainty is taken into account

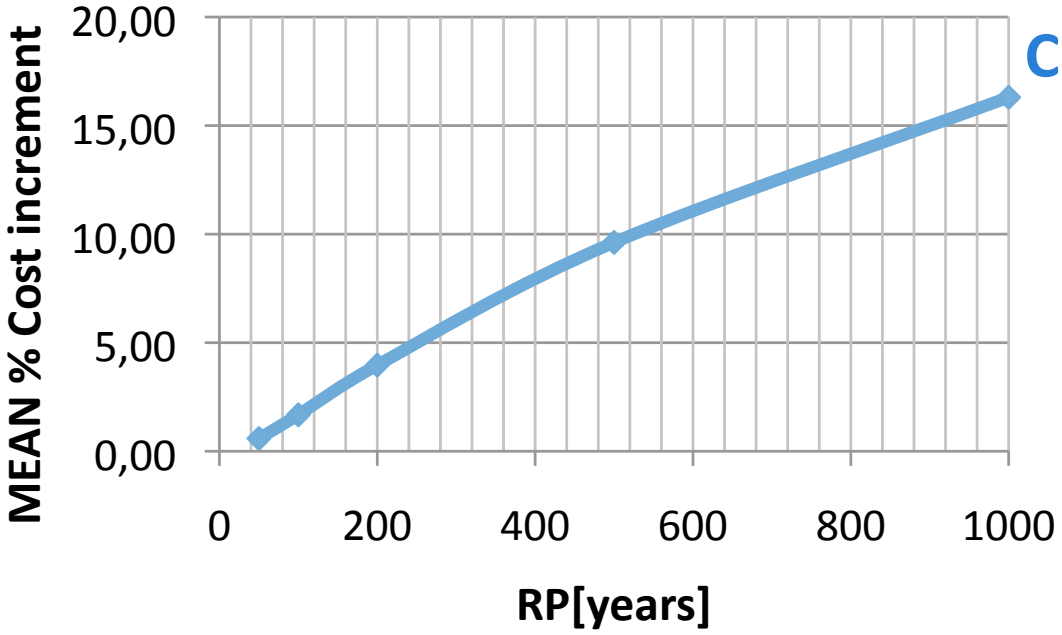
CASE STUDY

Results



Design flood estimator

In terms of magnitude Q, the increments is up to 58 % when T>200 years

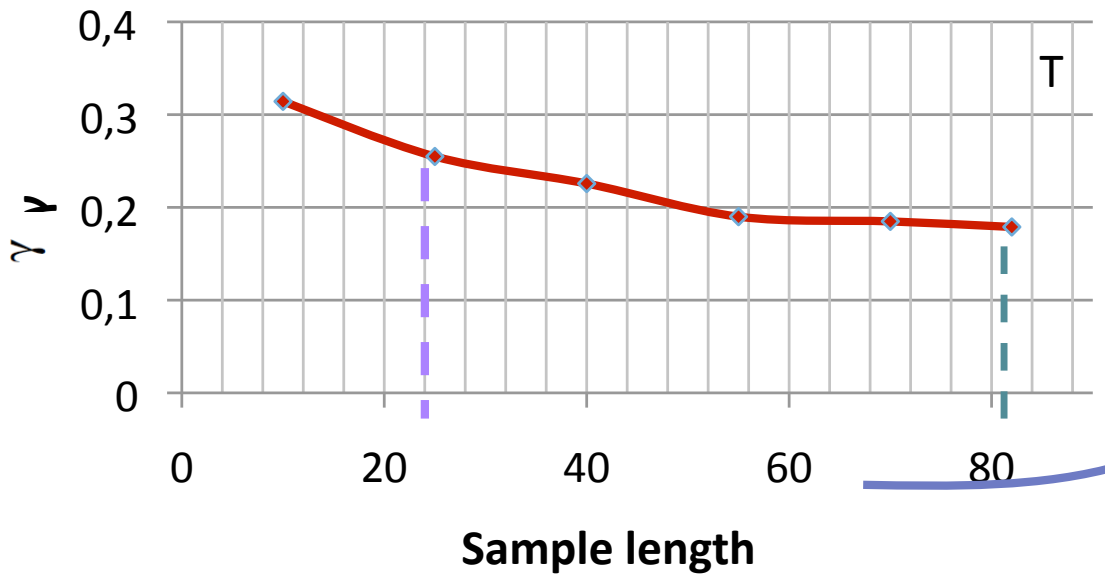


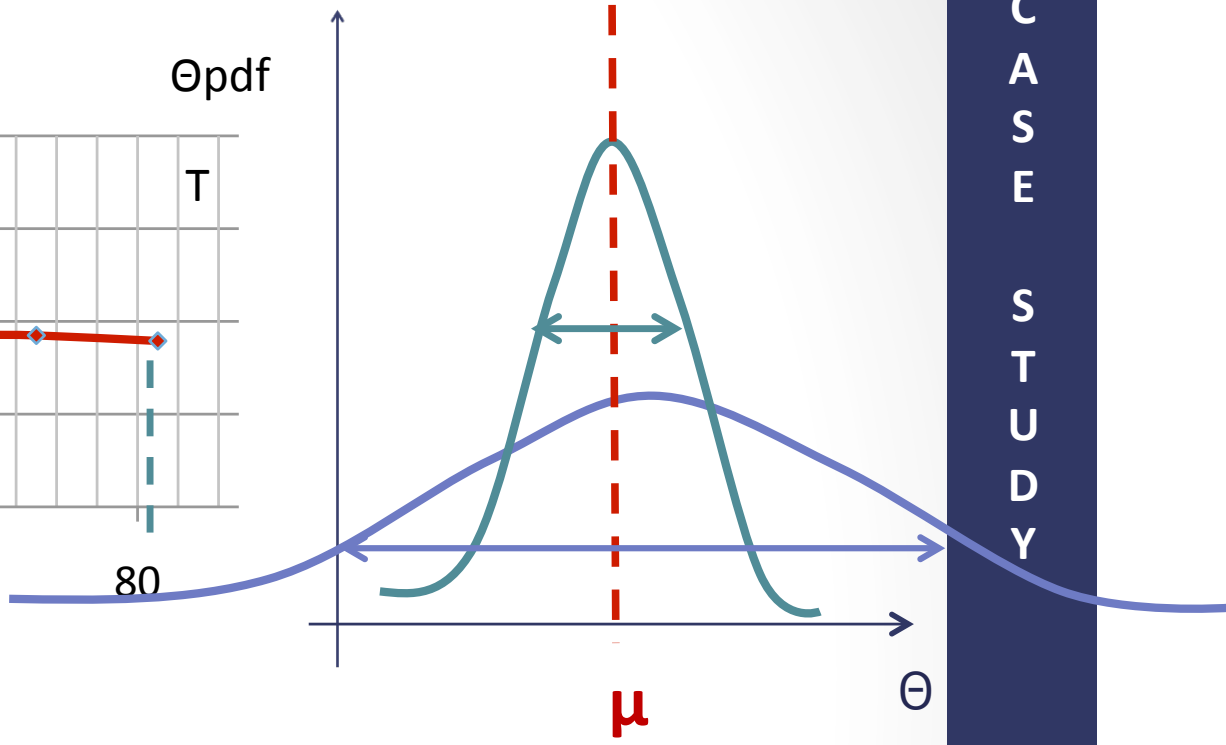
Cost increment / decrement

In terms of cost, the increments is up to 15 % when T>200 years

CASE STUDY

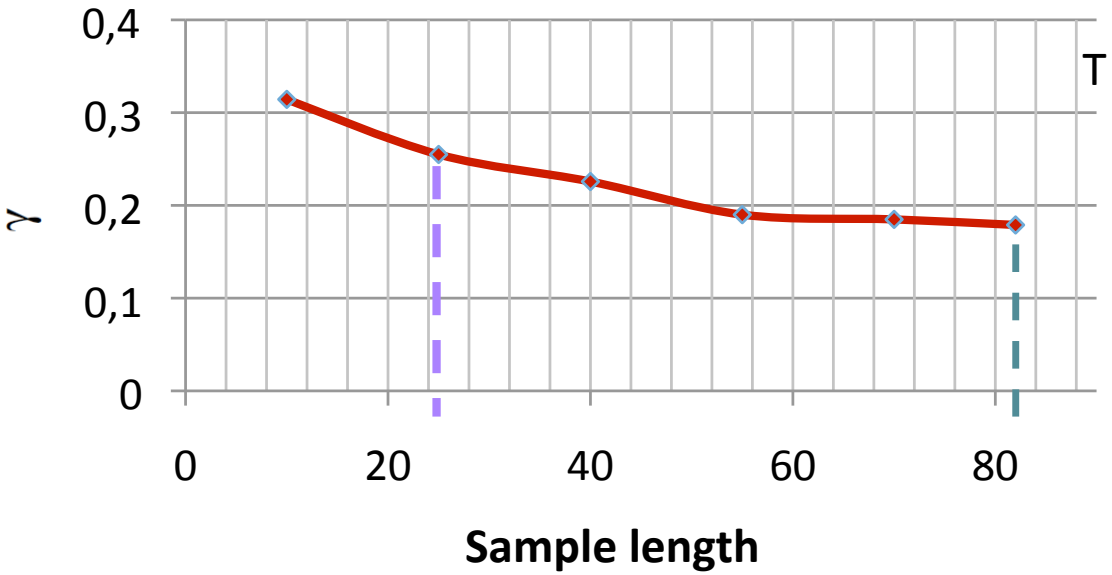
Results





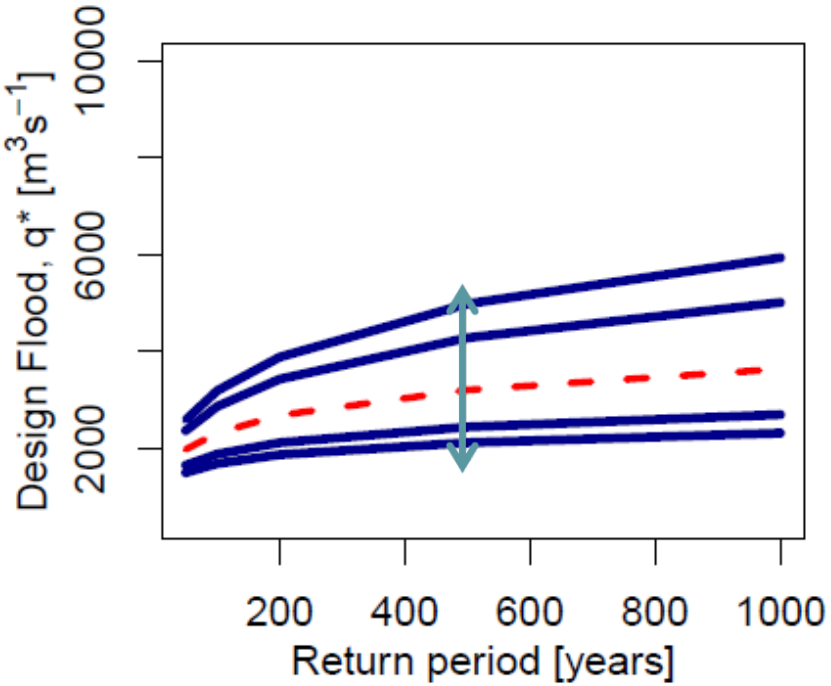
CASE STUDY

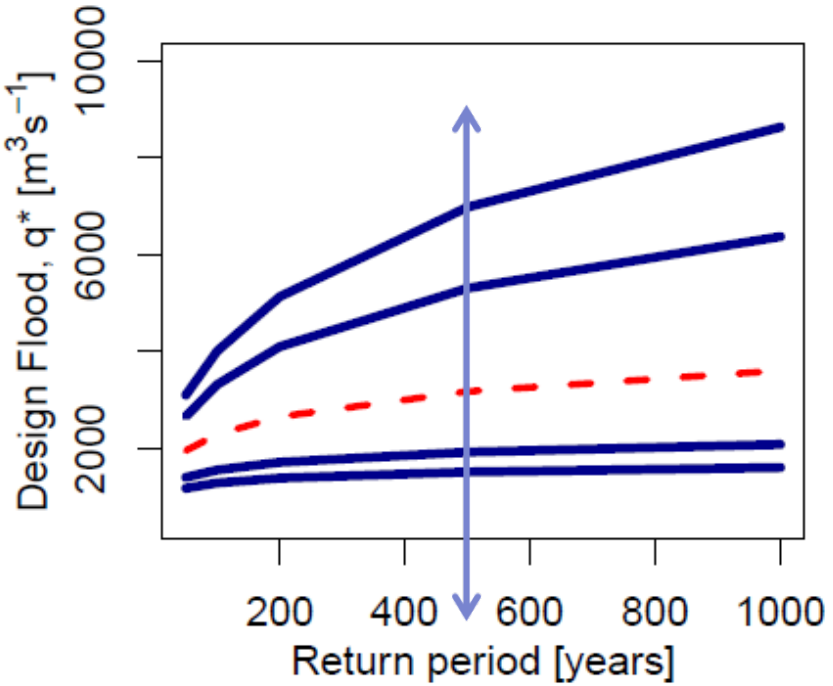
Results



- Small sample length entails higher value of γ
  - n=82→ γ = 0.17
  - n=25 → γ = 0.26

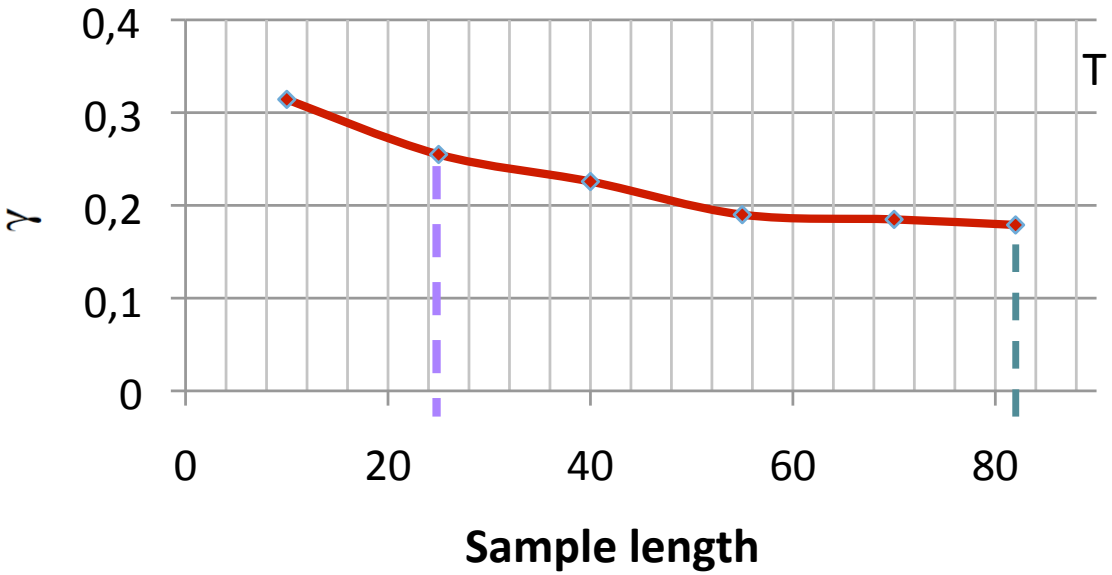
- In terms of magnitude Q:
  - n=82→ 15 %
  - n=25 → 43 %

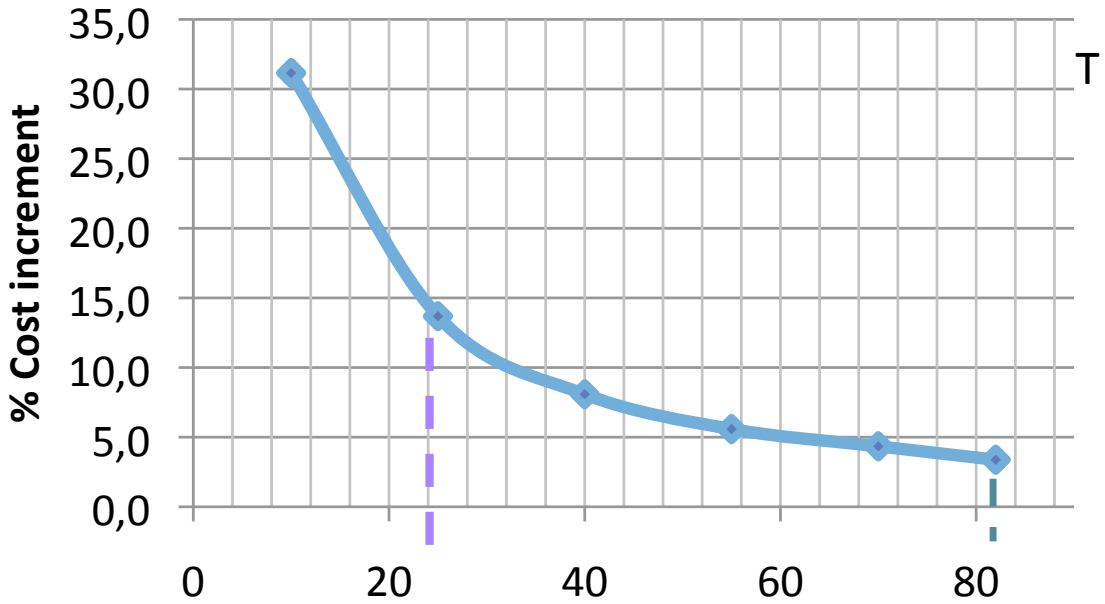




CASE STUDY

Results





- Small sample length entails higher value of γ
  - n=82→ γ = 0.17
  - n=25 → γ = 0.26

- In terms of magnitude Q:
  - n=82→ 15 %
  - n=25 → 43 %

- In terms of cost increment:
  - n=82→ 4%
  - n=25 → 14 %

CASE STUDY

Conclusions

CONCLUSIONS

•Cost-Benefit Analysis and Flood Frequency Analysis provide the same Design Flood Estimator when

- •LINEAR cost and damage functions are applied
- •C/D=T

•Parametric Uncertainty plays a role and leads to consistent displacement of the UNCODE flood estimator from the standard values, especially for high return periods (T>200y).

•When short data samples are considered, the differences become substantial:

- γ
- γ are larger
- are calculated on larger confidence bands

Thank you for your attention