Robust estimation of a quantile: hydraulic case study

ETICS 2018, Roscoff

SIMPLIFIED HYDRAULIC MODEL : PARAMETRIC CASE STUDY

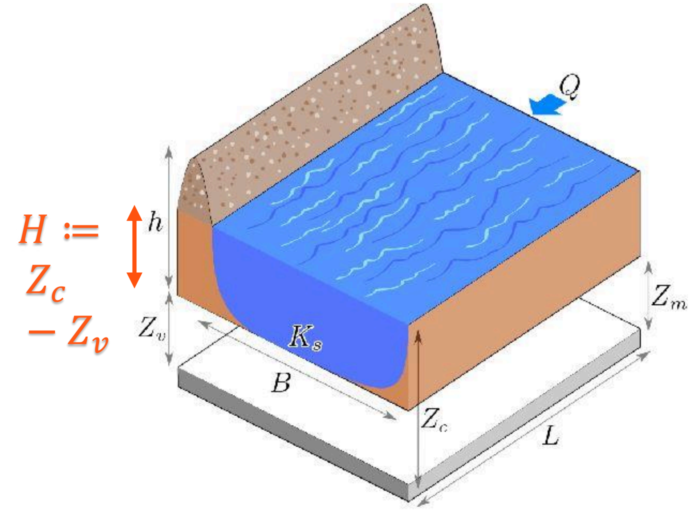
- **Four independent variables**

Variable	Distribution
Q : débit max. annuel (m^3/s)	Gumbel(mode=1013, échelle=558)
Ks : coefficient de Manning-Strickler $(m^{1/3}/s)$	Normal(μ=30, σ=7.5)
Zv : côte du fond de la rivière en aval (m)	Uniforme(49,51)
Zm : côte du fond de la rivière en amont (m)	Uniforme(54,55)

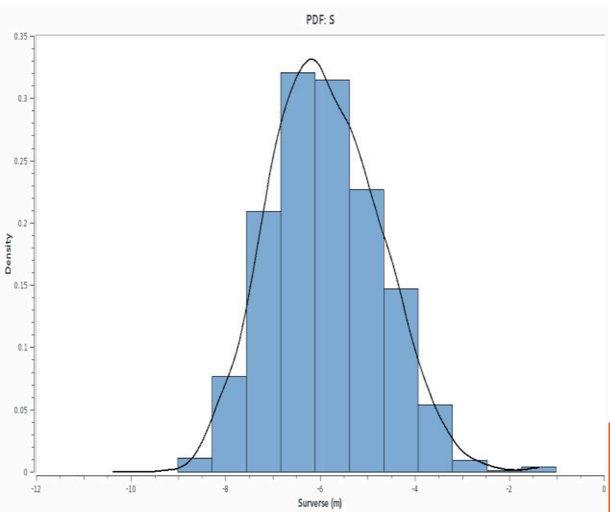
- **Output:** Water height H (in m)

$$H = \left(\frac{Q}{300 K_s \sqrt{\frac{Z_m - Z_m}{5000}}} \right)^{3/5}$$

- **Interest quantities:**
  - Flood probability : $p = P(H > h)$
  - α-quantile of H: $inf\{h, P(H \leq h) \geq \alpha\}$

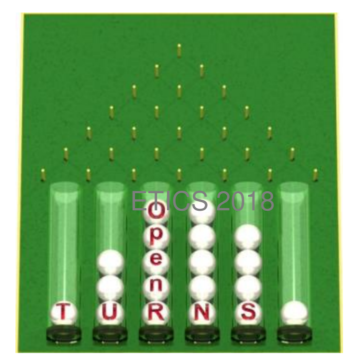


MONTE-CARLO CENTRAL TENDANCY ANALYSIS



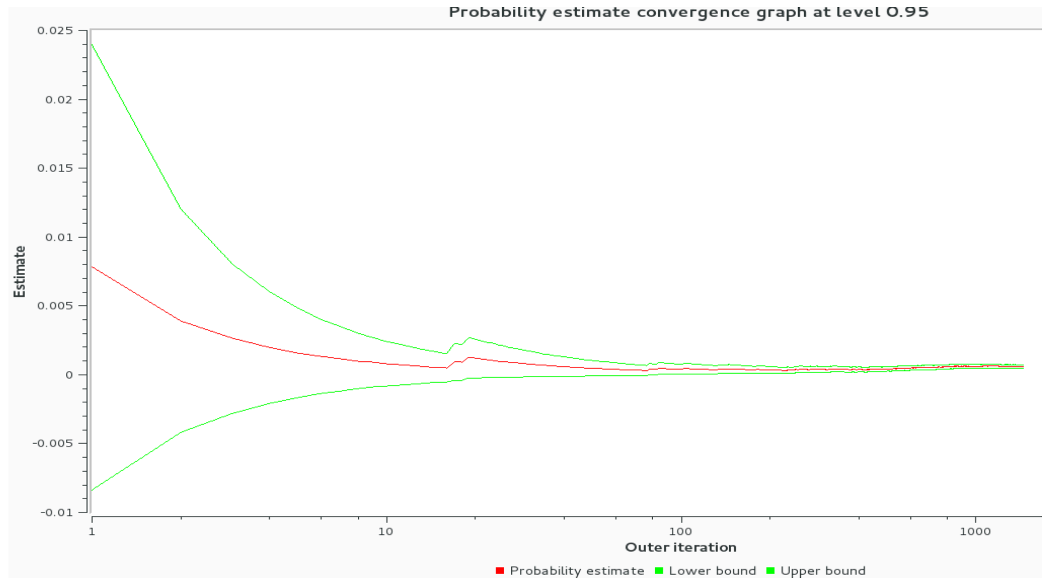
Estimate	Value	Conf. Int. 95%	
		Lower bound	Upper bound
Mean	- 5.8918	- 5.96386	- 5.81991
Std deviation	1.1613	1.11254	1.21456

- **Distribution of $H - h$, with $h = 5m$**
- **What do you think of the flood risk?**
- **Graphically, what seem to be the most influent variables?**



MONTE-CARLO ESTIMATE OF FLOOD PROBABILITY

- **What confidence can we have in these results?**
- **What if we chose different distributions for the input variables?**



Failure probability estimate

Estimate	Value	Confidence interval at 95%	
		Lower bound	Upper bound
Failure probability	0.000609809	0.000490585	0.000729032
Coefficient of variation	0.0997515		

SIMPLIFIED HYDRAULIC MODEL

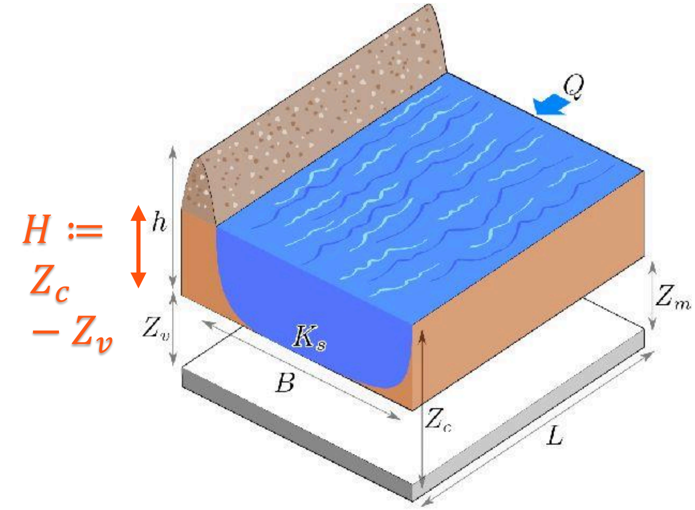
- **Four independent variables**

Variable	Bounds	Mean
Q : débit max. annuel (m^3/s)	160 3580	1870
Ks : coefficient de Manning-Strickler $(m^{1/3}/s)$	12.55 47.45	30
Zv : côte du fond de la rivière en aval (m)	49 51	50
Zm : côte du fond de la rivière en amont (m)	54 55	54.5

- **Output:** Water height H (in m)

$$H = \left(\frac{Q}{300 K_s \sqrt{\frac{Z_m - Z_m}{5000}}} \right)^{3/5} \in [0.5,9]$$

- **Interest quantities:**
  - Flood probability : $p = P(H > h)$
  - α-quantile of H: $inf\{h, P(H \leq h) \geq \alpha\}$



OBJECTIVE OF THE PRACTICAL SESSION

- **Estimate robust bounds on the tail probability or quantile of the water height H, based on the OUQ/robust inference framework**
- **Two cases considered her:**
  - **1D: Q only considered uncertain, all other variables set to their mean value → $H \in [0\ ;\ 5]$**
  - **4D: all variables considered uncertain → $H \in [0\ ;\ 9]$**
  - **In practice we are interested in water height thresholds $h > 3$**
- **Three methods considered here:**
  - **Simulated annealing**
  - **Differential evolution**
  - **Differential evolution in the mystic framework**