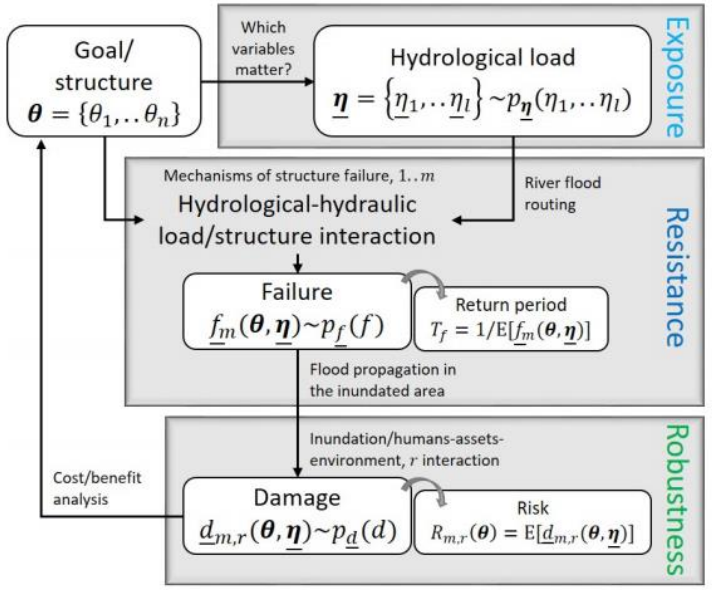
Design of offline reservoirs for flood mitigation by using a structure-based risk framework, (S. Cipollini and A. Fiori and E. Volpi)

Offline reservoir for flood mitigation: we assume the failure mechanism is determinated by the sole downstream peak flow Q

FLOOD RISK FRAMEWORK

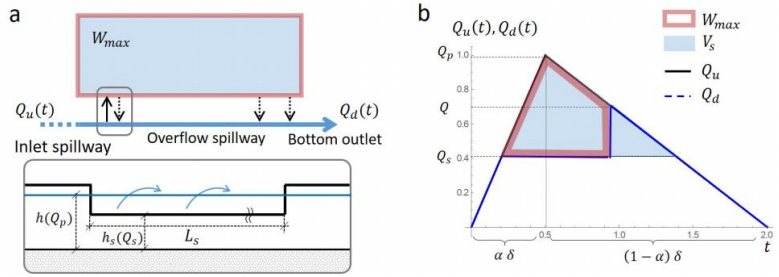


$$R_{m,r}(\theta) = \int d\ p_{\underline{d}}(d)\ \mathrm{d}d = \int .. \int d_{m,r}(\theta, \eta)\ p_{\underline{\eta}}(\eta_1, .. \eta_l)\ \mathrm{d}\eta_1 .. \mathrm{d}\eta_l$$

The key point is the **evaluation of the probability distribution function of damage and then of the risk**.

- Starting from the specific structure and goal at hand, **the relevant structures parameters are identified**;
- The goal drives the **identification of the relevant mechanisms of structure failure**, and, as a consequence, of the **hydrological load acting on the system** (***Exposure***);
- **Intermediate processes** and elements may modify the exposure within the system (***Resistence***);
- ***Robustness*** results from the **interaction of the flood with humans, exposed assets and environment**.

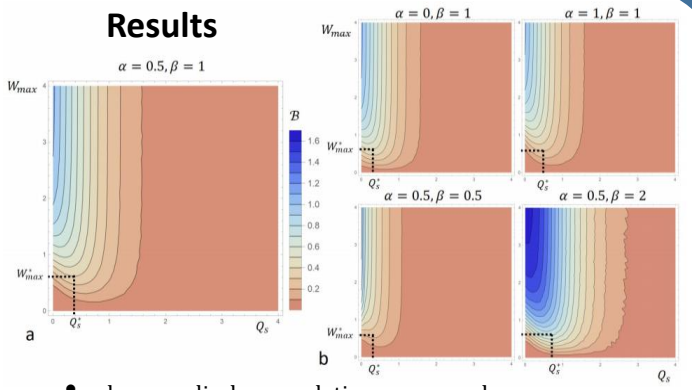
Simplified Modeling approach



- design parameters (h_s; W_{max}), (ideal side spillway $L_s \to \infty$) ;
- biavariate hydrological load (bivariate log-normal distribution (Q_p, V))
- triangular upstream hydrograph (peak position α)
- **simplified model for response Q of the reservoir** (structure function) $Q = g(Q_p, V)$

$$P_{\underline{Q}}(Q) = \int_{\mathcal{D}(Q)} p_{\underline{Q}_p,\underline{V}}(q_p, v)\ dq_p\ dv \qquad \mathcal{D}(Q) = \{(Q_p, V) \mid g(Q_p, V) \le Q\}$$

Results

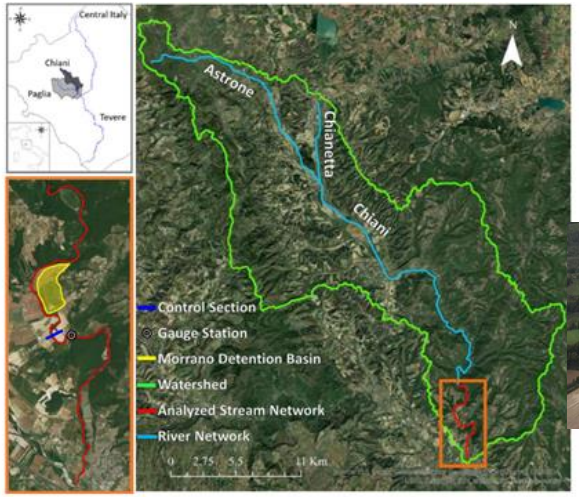


- damage-discharge relation as power-law

$$\underline{d} = \underline{Q}^{\beta} \qquad P_{\underline{d}} = P_{\underline{Q}_p} \text{ and } P_{\underline{d}} = P_{\underline{Q}}$$

and benefit $$\mathcal{B} = \int_{P_{\underline{Q}_p}(Q_0)}^{1} Q^{\beta}\ dP_{\underline{Q}_p} - \int_{P_{\underline{Q}}(Q_0)}^{1} Q^{\beta}\ dP_{\underline{Q}}$$

Case study: Chiani River (Italy)



- design parameters (h_s;L_s), (W_{max} constrained by the extent of the area);
- bivariate hydrological load (Gumbel-Hougaard copula $P_{\underline{Q}_p,\underline{V}}$)
- rainfall-runoff linear model (geomorphological IUH);
- (1D) hydrodynamic model
- **Monte Carlo approach for response Q of the reserovir**

Morrano Reservoir (November, 2012)

Results