FLASH FLOODS AND PLUVIAL FLOODING

ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

REGIONE AUTONOMA DELLA SARDEGNA

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE

Working Group F Thematic Workshop

Flash Flood Guidance based on Rainfall Thresholds: an example of a probabilistic decision approach for early warning systems

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Outline

- Basics for a probabilistic decision approach
- An example of a FF warning system based on Rainfall Thresholds

x	y
Rainfall	Discharge
Water depth	Water depth
Snow	Landslide
Temperature	Debrisflow

$$y = M(x)$$

Deterministic Model

$$f(y|x)$$

Statistical Model

Predictor(s)

Measured

(Forecasted)

Predictand

Effects

Damages

Vulnerability

Decisions
(Costs)

Predictor(s) → Predictand

$$\mathrm{Risk}(x, y) = f(y \mid x) \cdot \mathrm{Vul}(y)$$

$$\mathrm{Cost}\,(x, y) = f\,(y \mid x) \cdot \mathrm{Damage}\,(y)$$

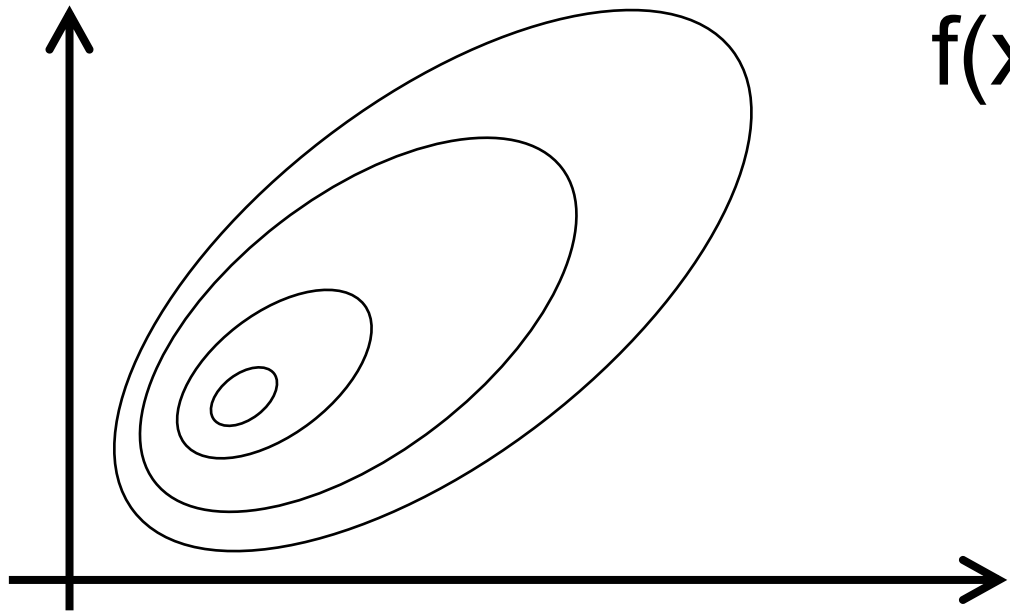
$$\mathrm{E}[\mathrm{Risk}(x,y)] = \int f(y \mid x) \cdot \mathrm{Vul}(y)\, dy$$

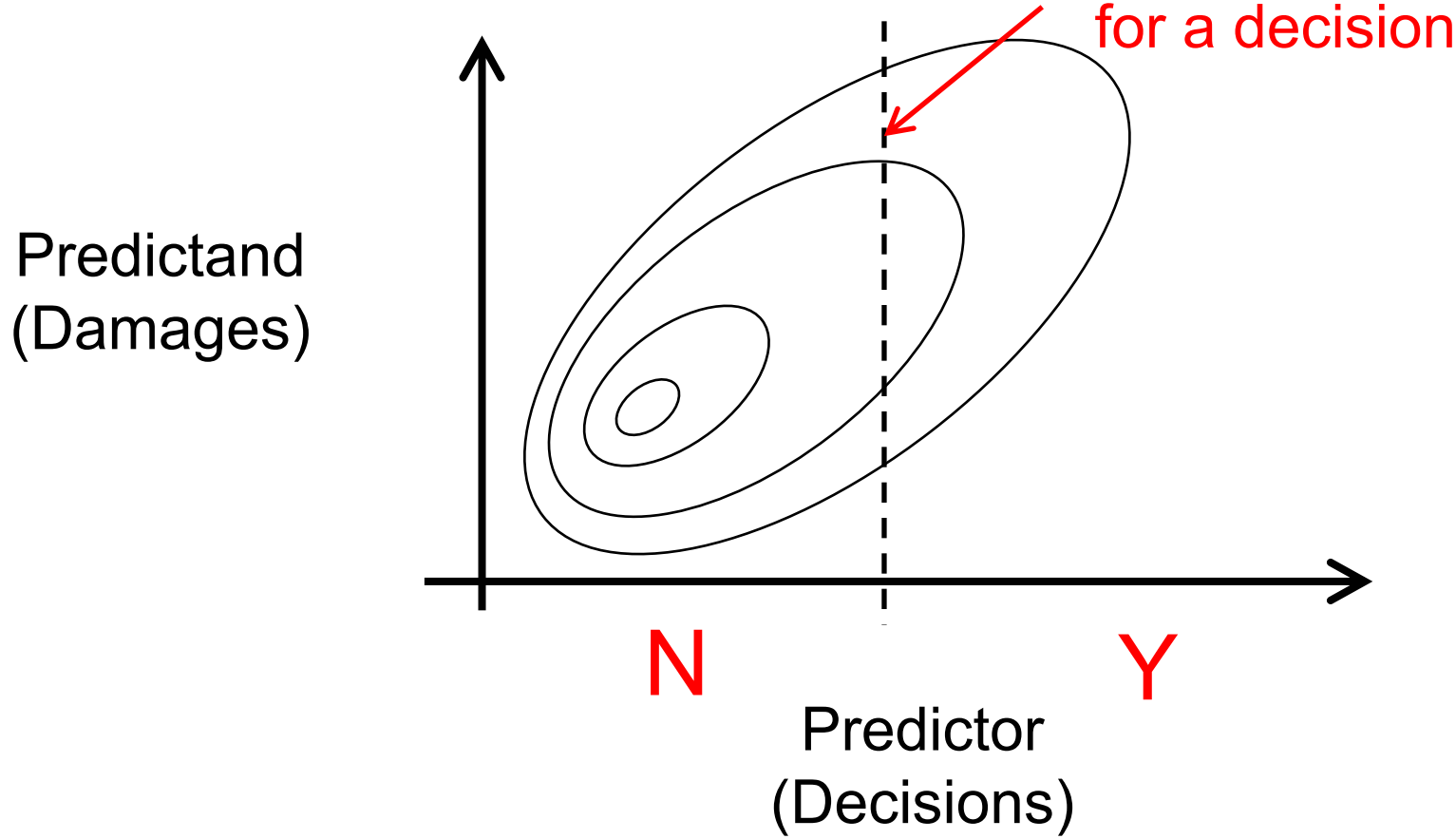
$$\mathrm{E}[\mathrm{Cost}\,(x,y)] = \int f(y \mid x) \cdot \mathrm{Damage}\,(y)\, dy$$

Predictor(s) → Predictand

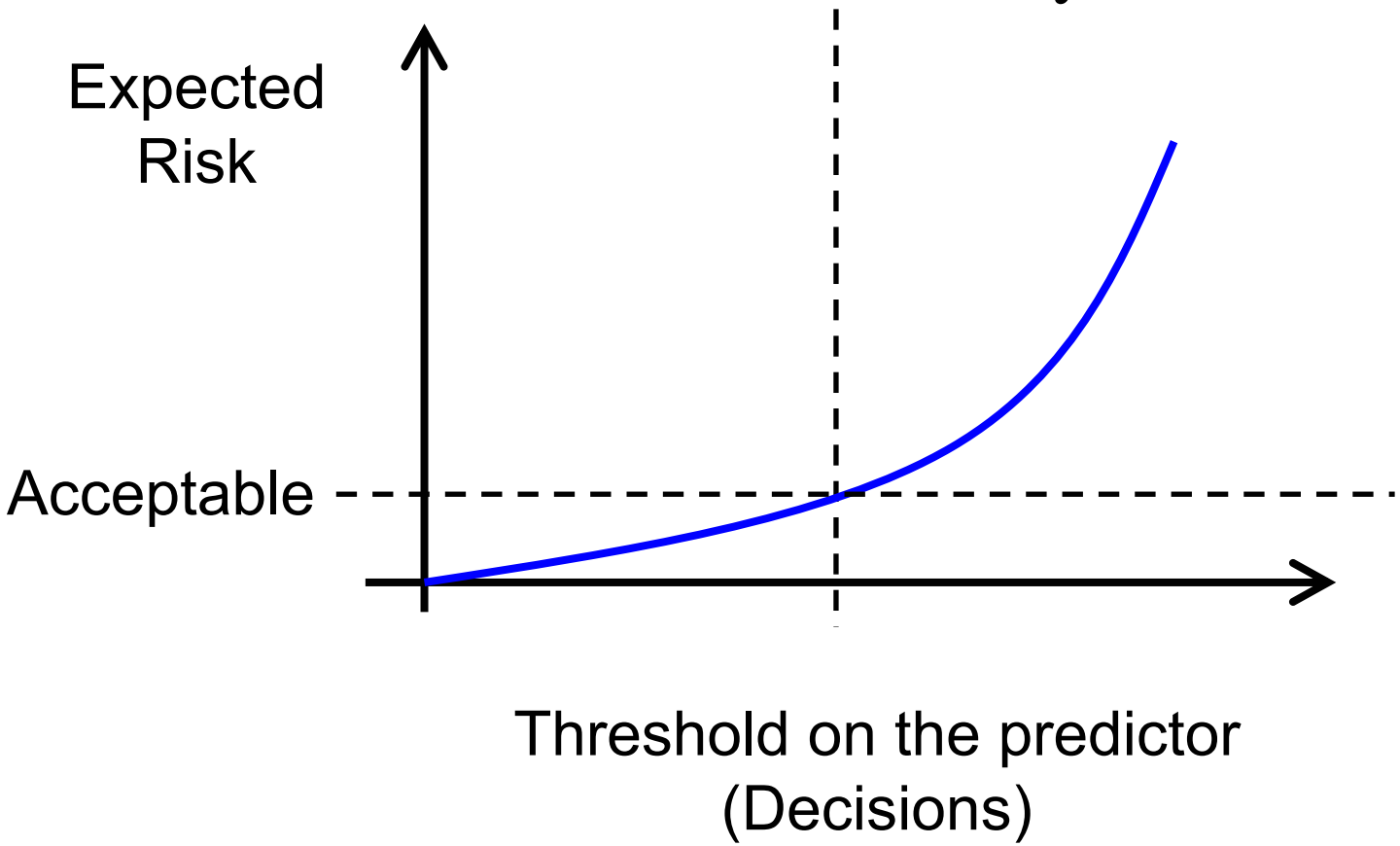
$$\hat{R}(x) = \int f(y \mid x) \cdot \mathrm{Vul}(y)\, dy$$

$$\hat{C}(x) = \int f(y \mid x) \cdot \mathrm{Damage}(y)\, dy$$

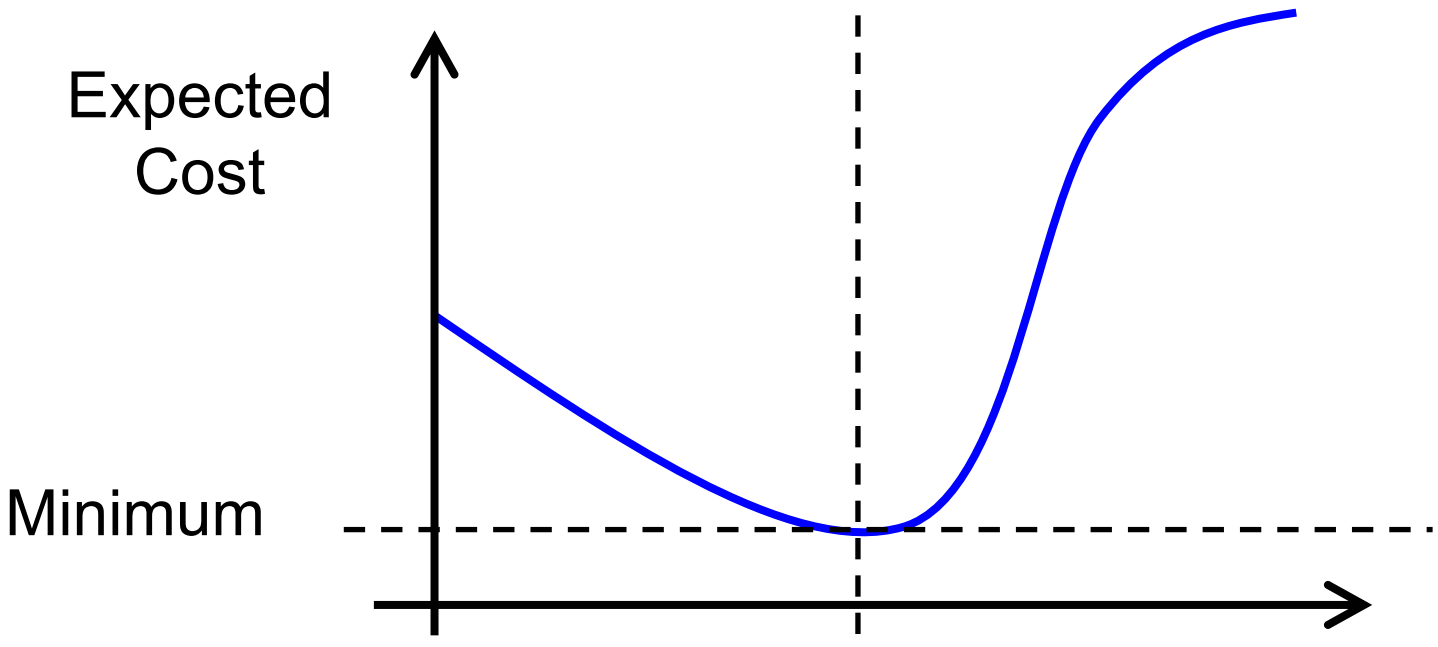

f(x,y)
Predictand
(Damages)
Predictor
(Decisions)


Threshold
for a decision
Predictand
(Damages)
N
Y
Predictor
(Decisions)

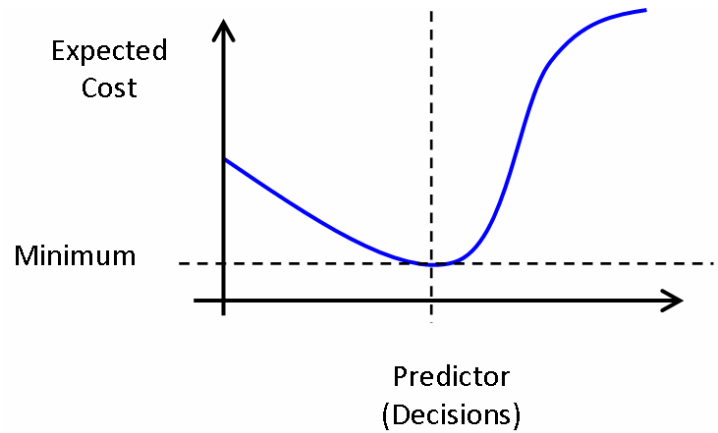
$$\hat{R}(x) = \int f(y \mid x) \cdot \mathrm{Vul}(y)\, dy$$



$$\hat{C}(x) = \int f(y \mid x) \cdot \text{Damage}(y)\, dy$$



$$\hat{C}(x) = \int f(y \mid x) \cdot \left(\text{Damage}(y) + \text{MC}(x, y) \right) dy$$



An example

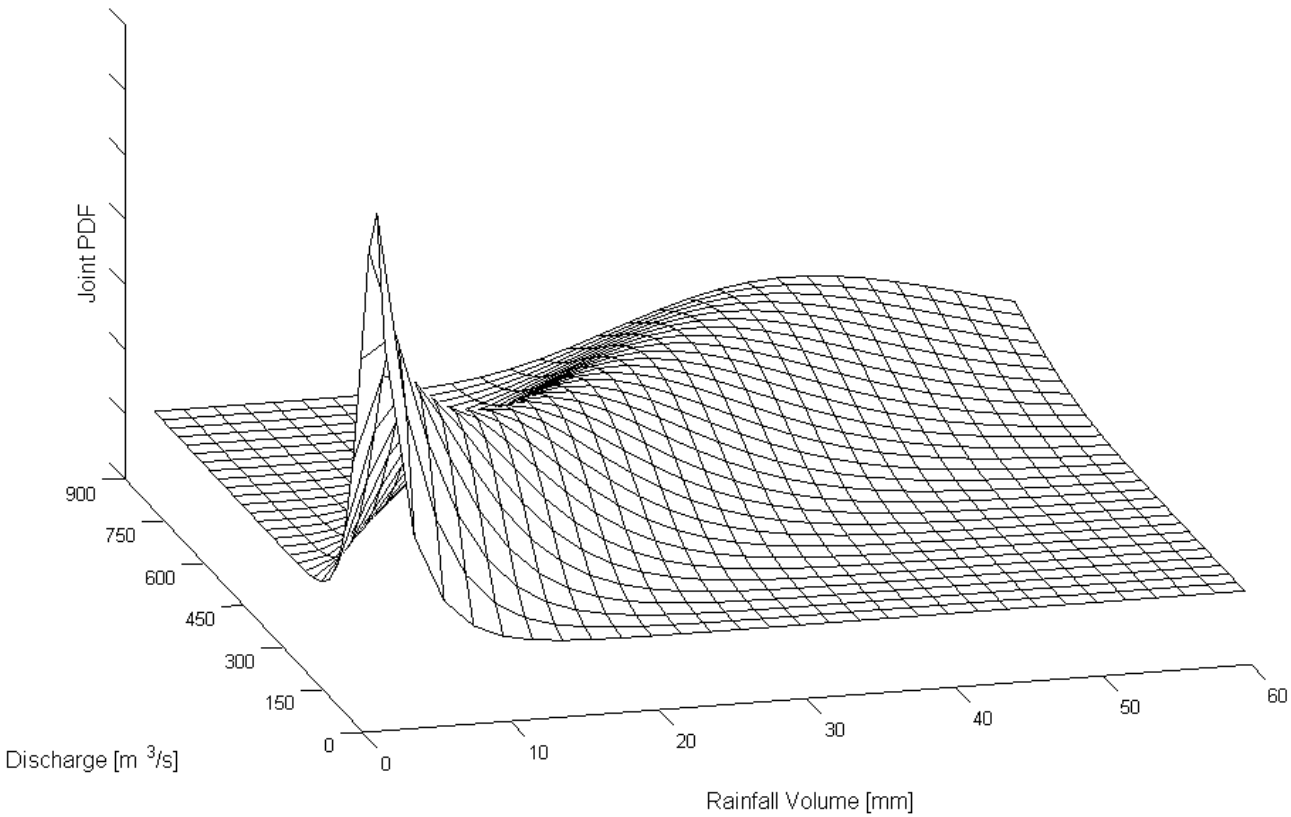
Rainfall

f(y|x)
Statistical Model

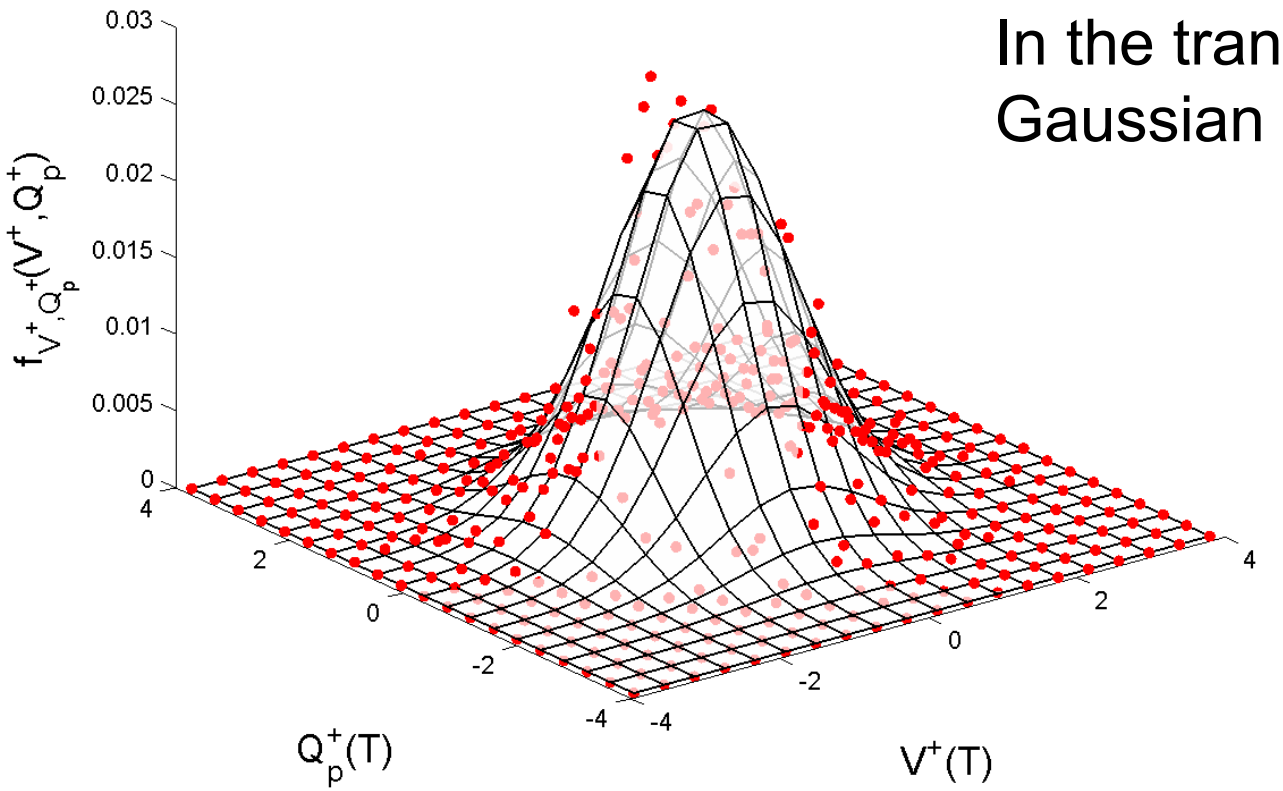
Discharge

Application on several catchments (Reno, Sieve, Posina, Serchio, Iran)

The joint distribution f(x,y)

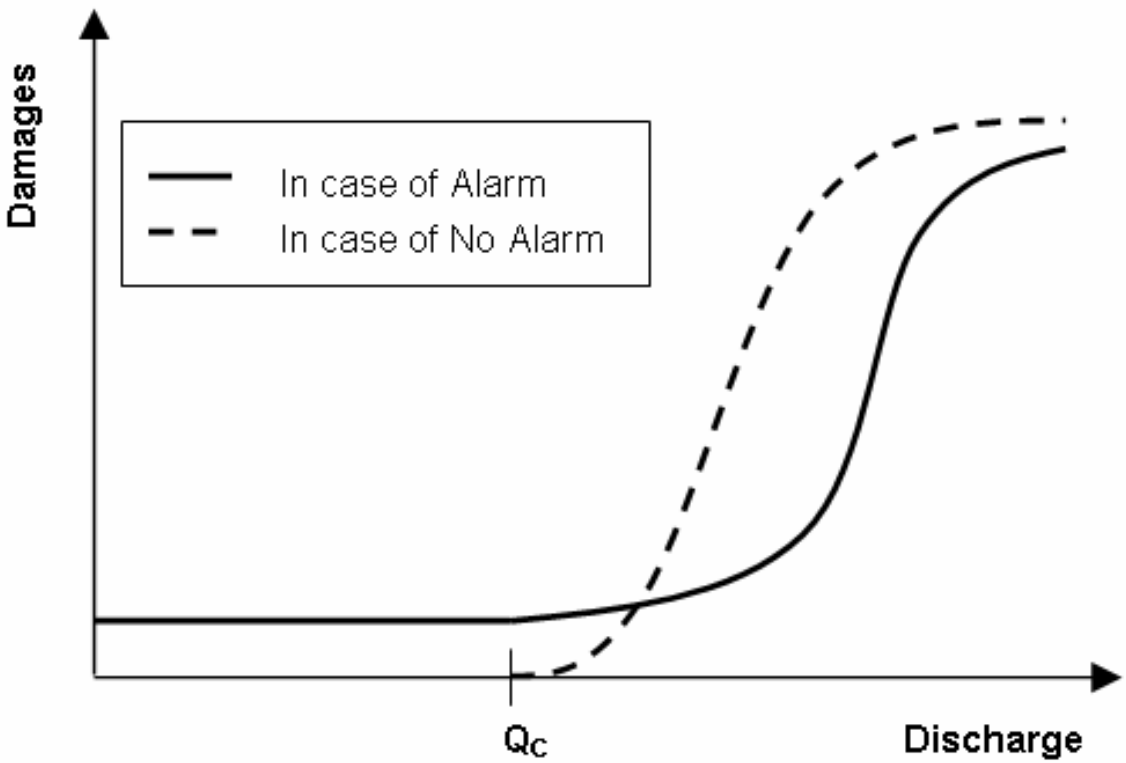


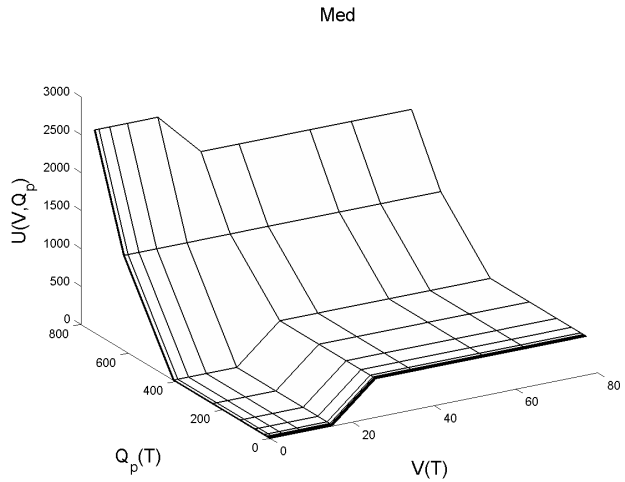
The joint distribution f(x.v)



In the transformed Gaussian space

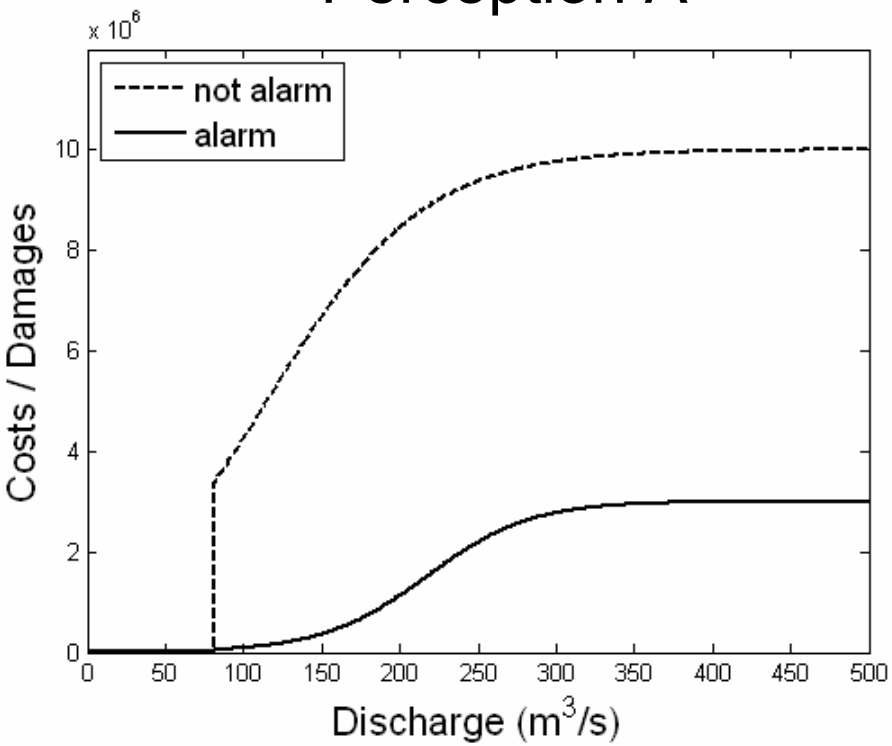
The damages/cost function



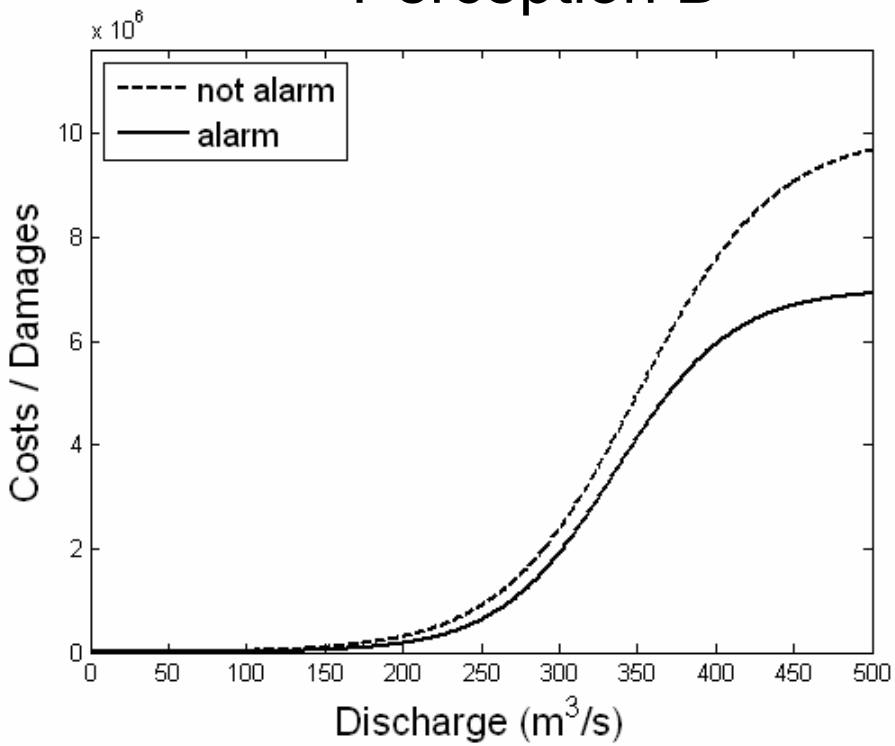


The damages/cost function

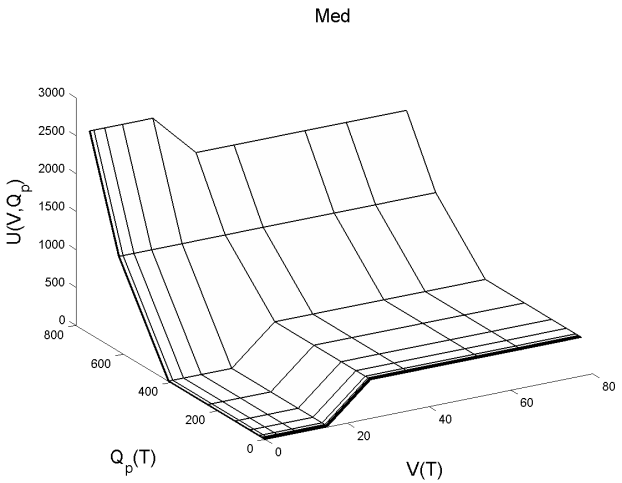
Perception A



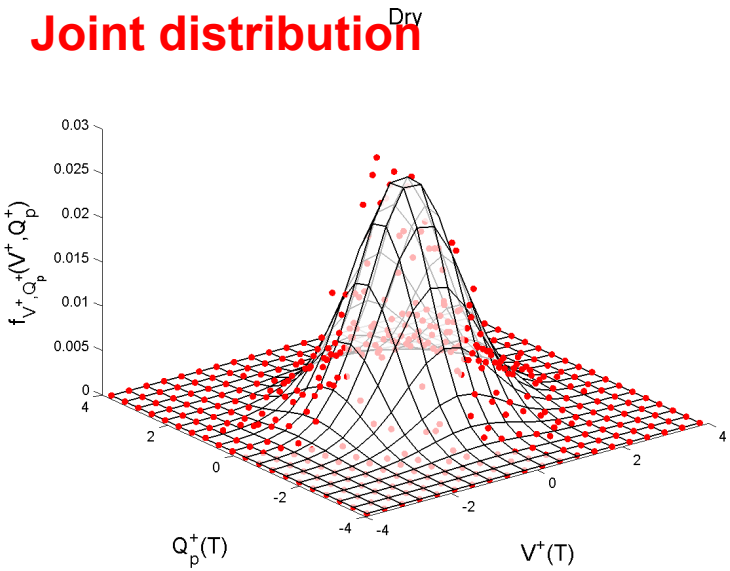
Perception B



Costs

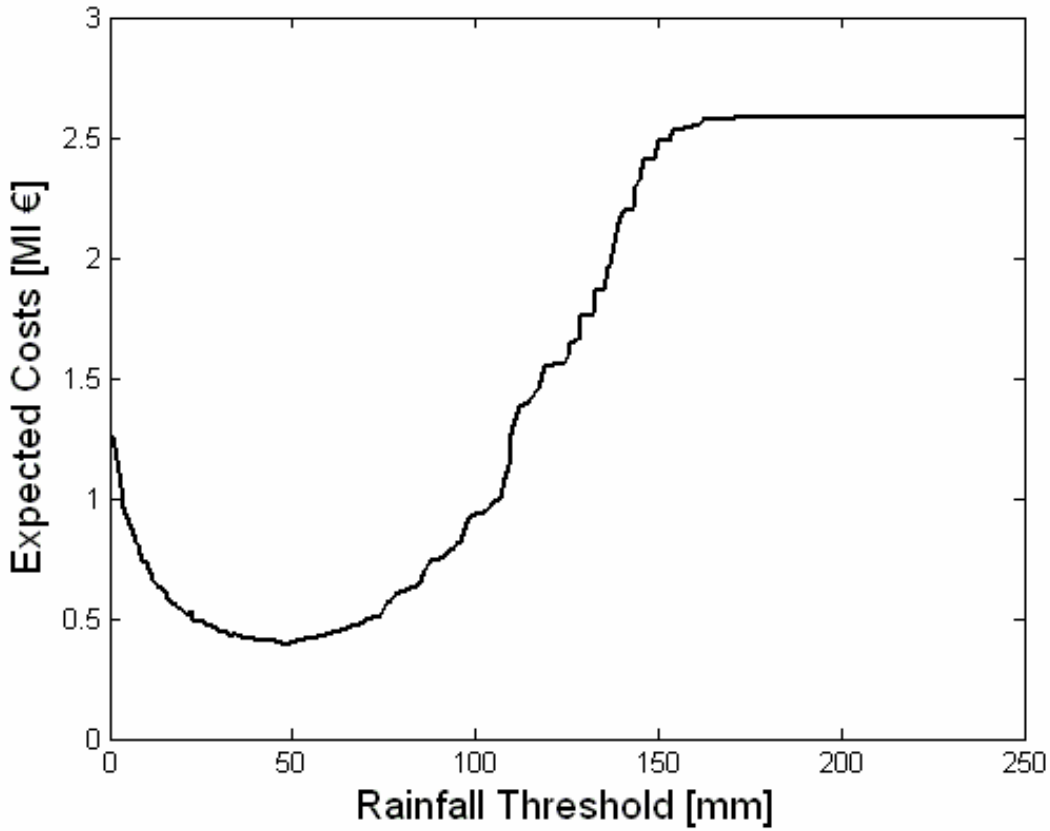


Joint distribution



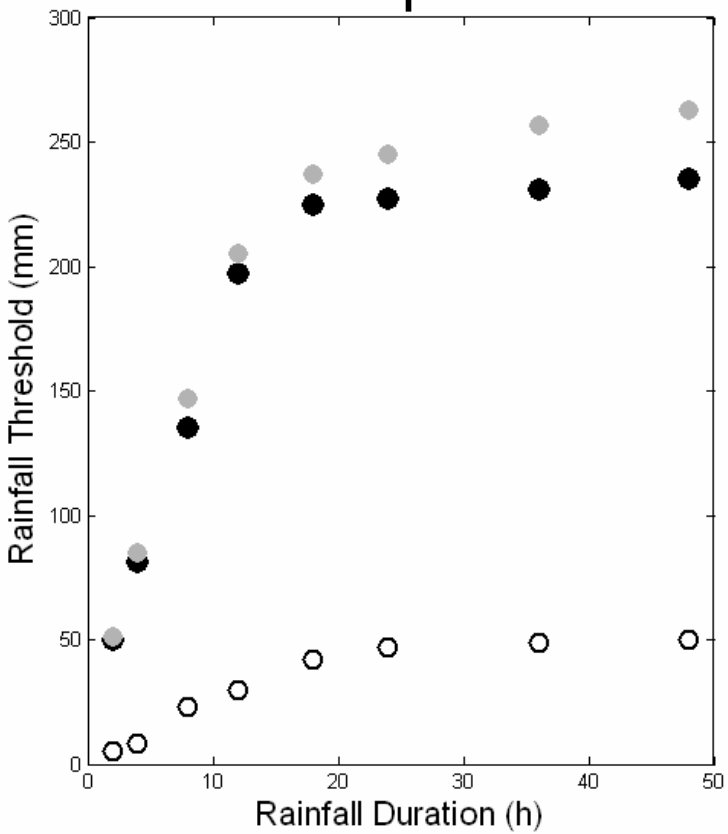
$$\hat{C}(x) = \int f(y \mid x) \cdot \left(\text{Damage}(y) + \text{MC}(x, y) \right) dy$$

Expected cost

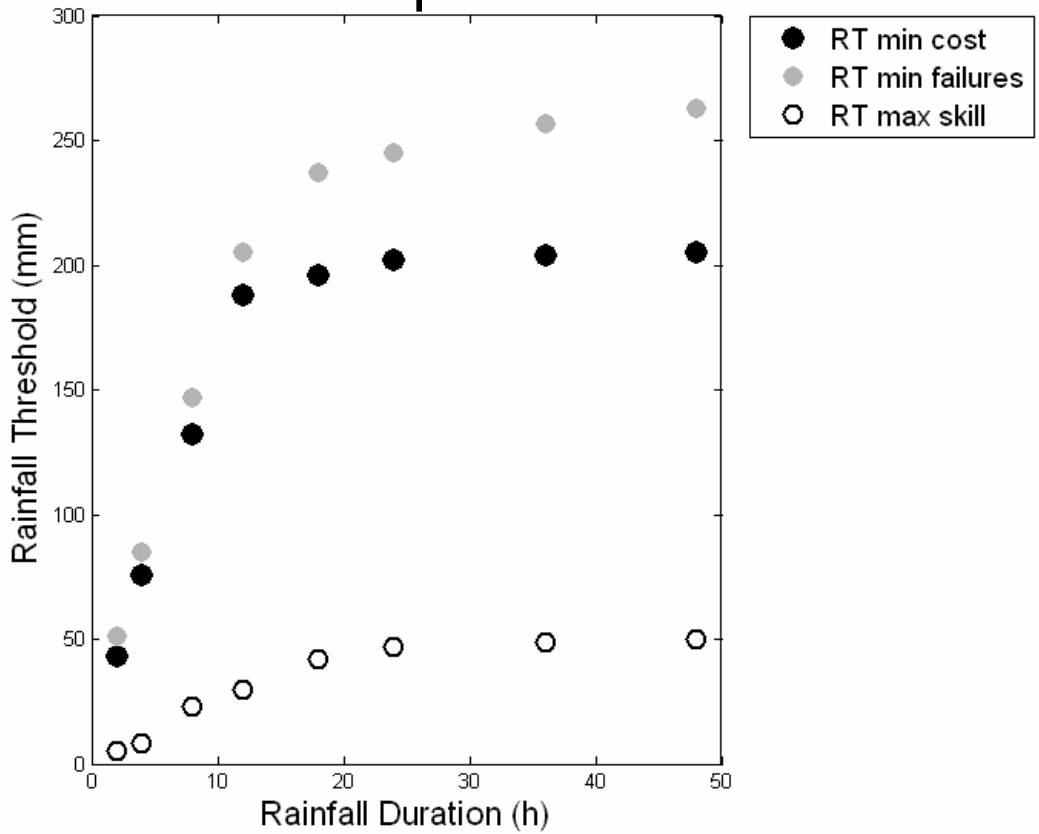


Rainfall thresholds

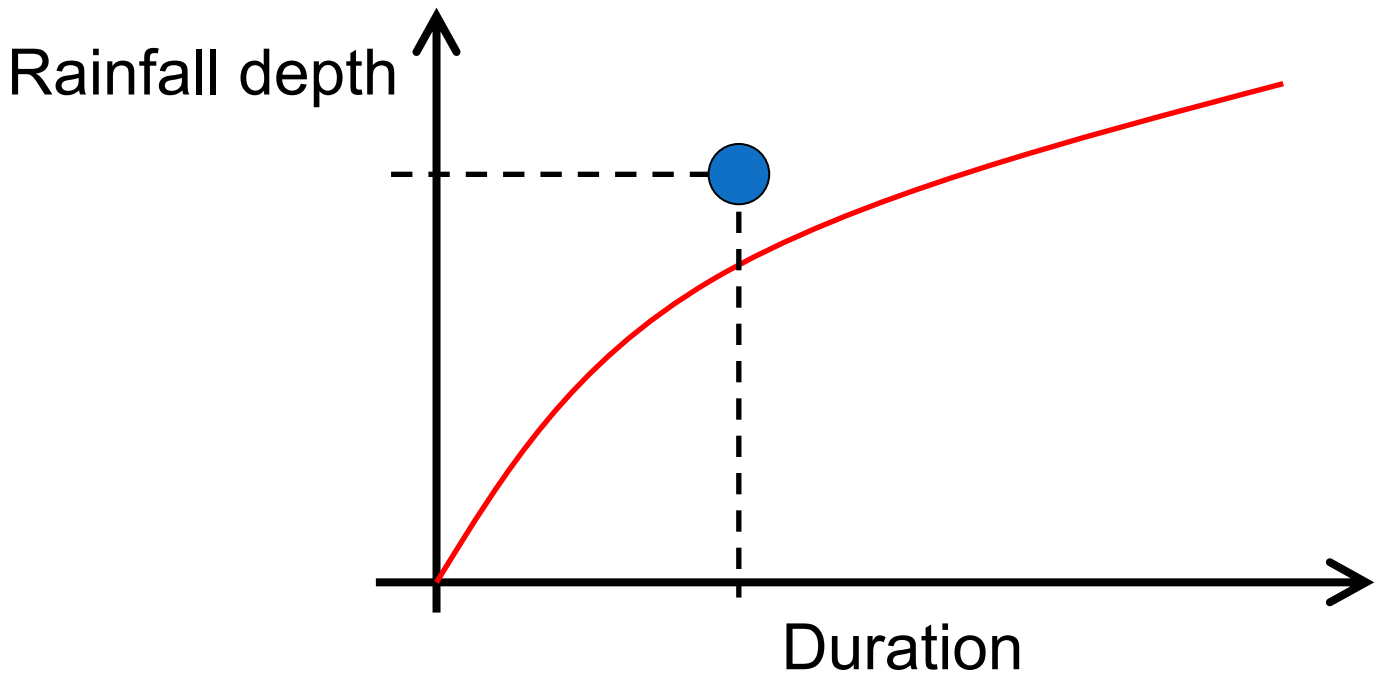
Perception A



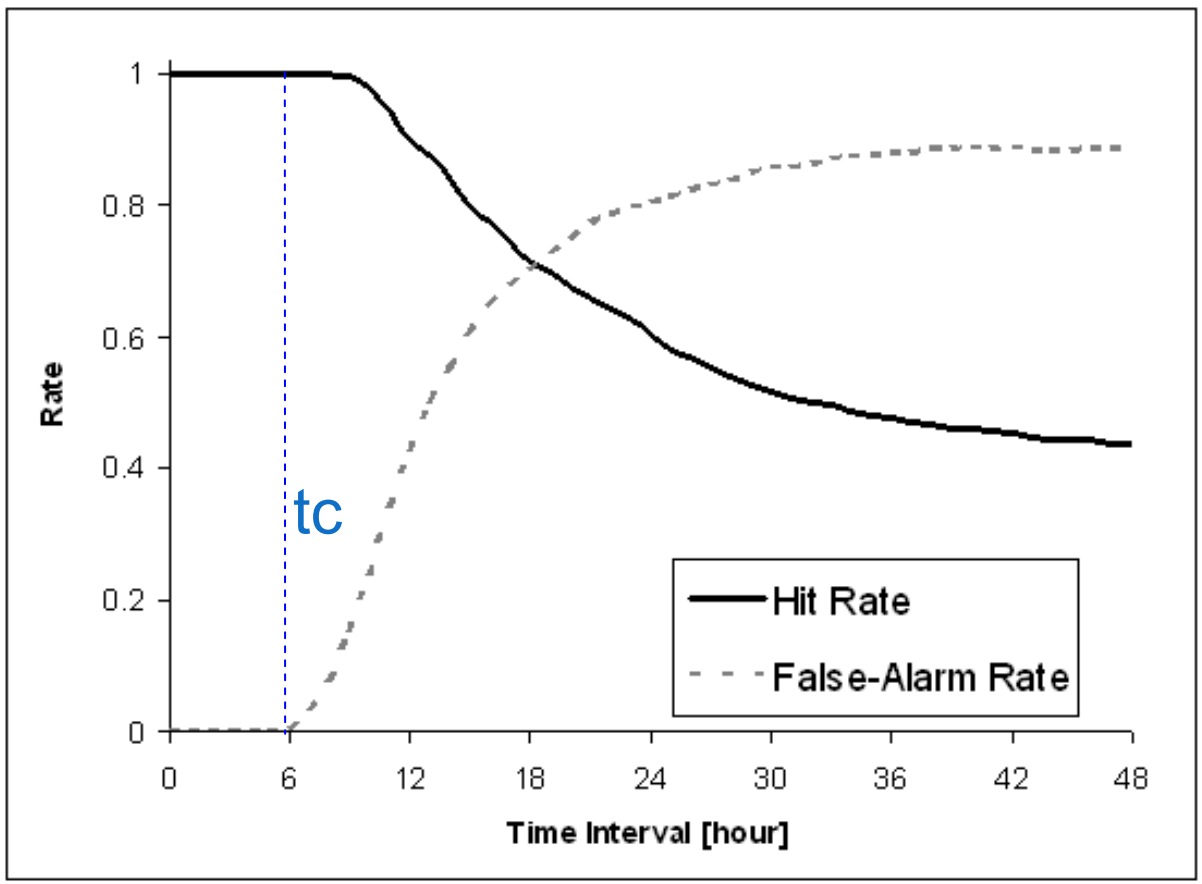
Perception B



The operational use



Skills (case with no uncertainty in the rainfall)



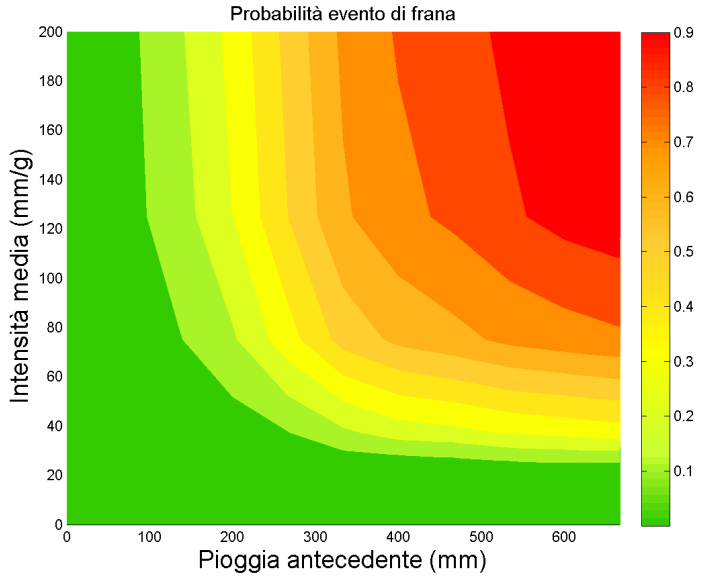
Other example could be

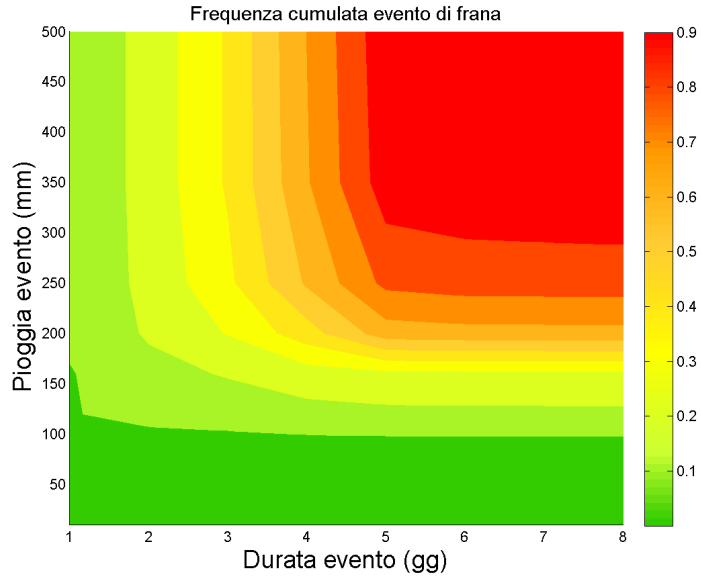
Rainfall

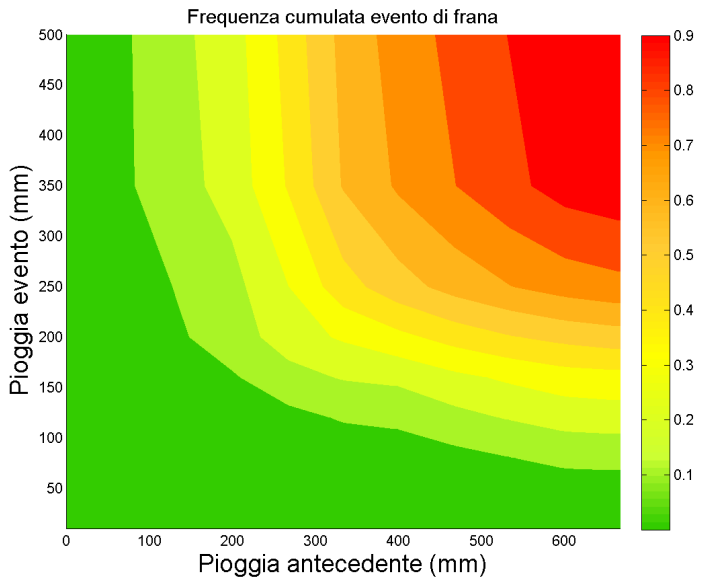
f(y|x)
Statistical Model

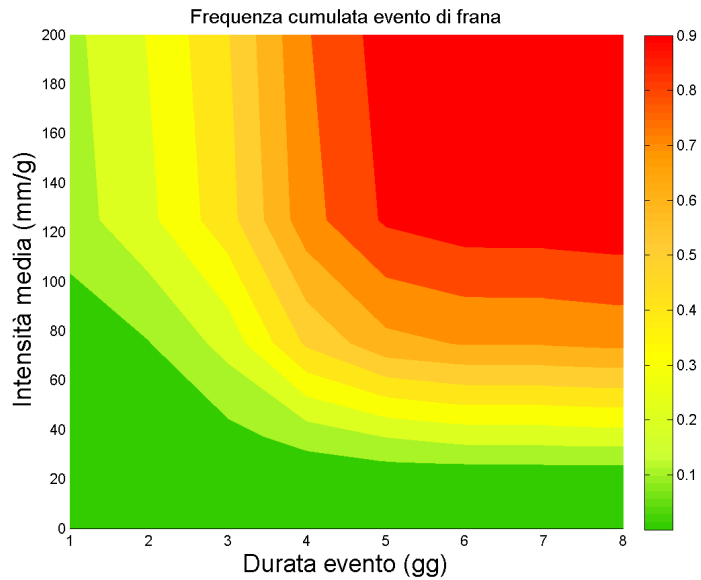
Landslides

Application on several catchments (Reno, Sieve, Posina, Serchio, Iran)


Probabilità evento di frana
Intensità media (mm/g)
Pioggia antecedente (mm)


Frequenza cumulata evento di frana
Pioggia evento (mm)
Durata evento (gg)


Frequenza cumulata evento di frana
Pioggia evento (mm)
Pioggia antecedente (mm)


Frequenza cumulata evento di frana
Intensità media (mm/g)
Durata evento (gg)

Considerations

- A FFG should be based on a risk (cost) analysis
- The damages related to the flood and the cost or reduction of the warning systems should be incorporated in the analysis
- The definition of the “Threshold” is based on the definition of a accepted level or risk or on the minimization of the costs