BORIS

Cross **BO**rder **RIS**k assessment for increased prevention and preparedness in Europe

Methodology for multi-risk assessment

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Why multi-risk?

- "to make informed decisions on **priorities in risk management**, spatial planning or risk communication, it is necessary to consider all hazards and know all risks relevant to the area under investigation (Durham, 2003)"

Single-hazard Only one hazard considered	**Single-risk** Risk in a single-hazard framework
Multilayer single-hazard More than one hazard No hazard interactions	**Single-risk** Risk in a multilayer single-hazard framework No interactions on the vulnerability level
Multihazard More than one hazard Hazard interactions considered	**Multihazard risk** Risk in a multihazard framework No interactions on the vulnerability level
	Multirisk Risk in a multihazard framework Interactions on the vulnerability level considered

Zschau (2017)

MULTILAYER SINGLE-RISK FRAMEWORK.

to understand relative importance of risks in a region

Multi-layer single-risk assessment

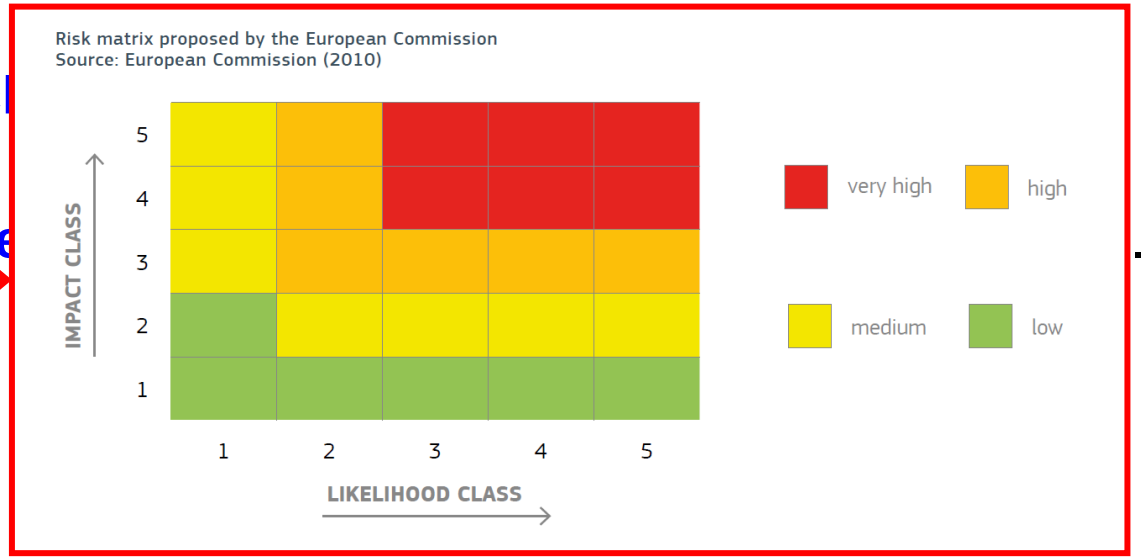
Multilayer single-hazard/ risk assessment approach

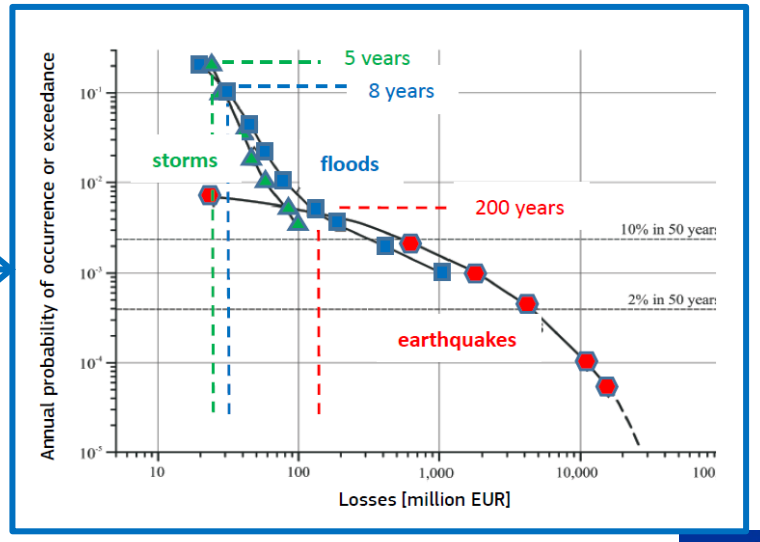
- ✓ ignoring the interactions
- ✓ **harmonising** and **standardising the asse**

Possible standardization schemes

- Risk Matrices (for classification; qualitative or semi-quantitative)
- Risk Indices (semi-quantitative)
- Risk Curves (quantitative)

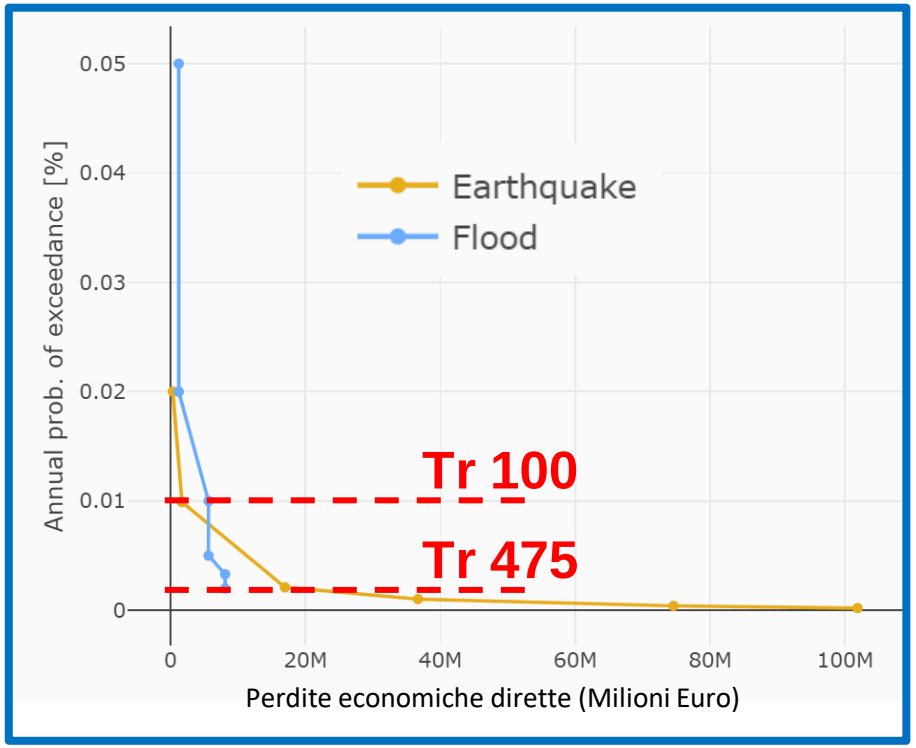
more indicated when different dimensions of risk need to be considered (e.g. SOVI)





Risk Curves

- The risk curves or functions represent the more quantitative methods for assessing natural threats in a multilayer single-hazard approach
- Allow time-based assessment → Can be effectively used for comparing and ranking the risks
- Allow comparison of hazard effect at different Tr
  - for Tr 100 flood losses are predominant
  - for Tr 475 seismic losses are higher



It is indicated to consider the Integral

The **area under the frequency-loss curve** represents all the possible losses that are associated to the different annual frequencies, that is the **mean expected annual loss EAL**

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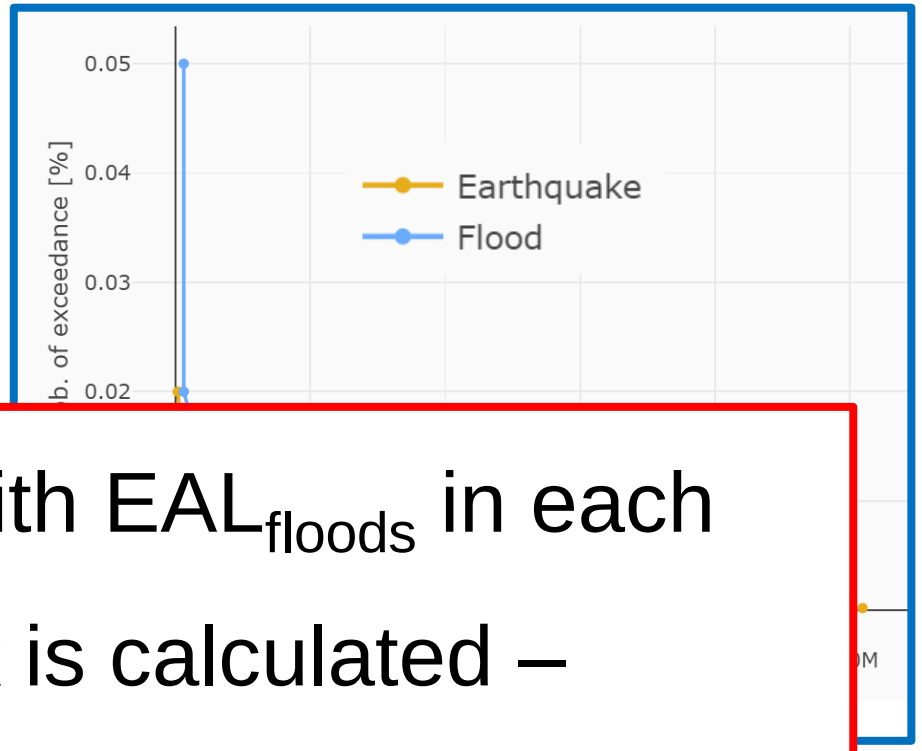

Possibility to compare $EAL_{seismic}$ with EAL_{floods} in each geographic location where risk is calculated – e.g. municipality

It is

Th

represents all the possible losses that are associated to the different annual frequencies, that is the **mean expected annual loss EAL**

RANKING THE RISKS

- The ranking of risks requires that each typology is calculated using the same boundary conditions.

- First of all it is necessary to define a common timeframe → ESTABLISH A TIME-FRAME

- and the specific kind of damage we are interested in → ESTABLISH A METRIC

RISK CURVES can be used for this purpose
(deriving them according to established metric)

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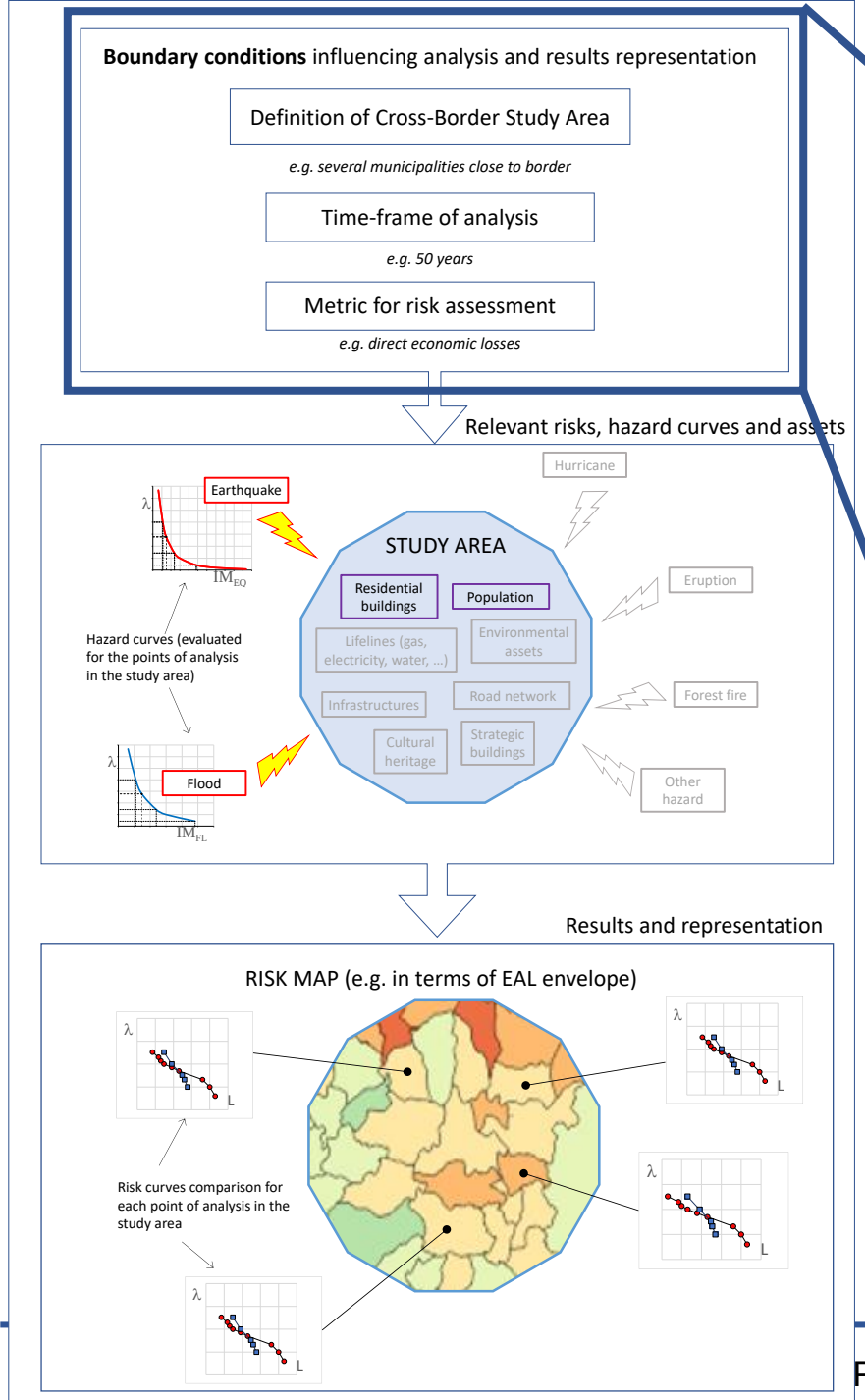

BOUNDARY CONDITIONS

Definition of cross-border study area

e.g. municipalities in transboundary zone

Time frame of analysis

e.g. 1 year or 50 years

Metric for risk assessment

e.g. direct economic losses

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Cross-border study area

Spatial scale for multi-risk

- The optimal spatial scale for risk assessment can vary from one risk to another
- should allow the aggregation of the consequences to the same spatial units

MUNICIPALITY SCALE

- ✓ Sufficiently small to provide risk results useful to support end-users for rational decision-making
- ✓ Attainable both in the case of the seismic and the flood risk assessment

METRIC FOR RISK ASSESSMENT

- collapsed buildings;
- unusable buildings;
- nr deaths;
- nr Injured;
- Displaced people;
- Downtime;
- Economic losses (direct)
- *…. Other…*

Direct economic losses

Direct Losses due to Seismic damage

$$L = CU\left(\sum_{j=1}^{n_t}\sum_{k=1}^{5} A_j \, p_{j,k} \cdot c_k\right)$$

- $p_{j,k}$ is the probability for the jth building typology to experience structural damage state Dk
- A_j is the built area of the jth building typology
- CU is the Unit cost (Euro/m^2) of a building
- n_t is the number of building typologies
- c_k is the percentage cost of repair or replacement (with respect to CU) for each structural damage state Dk

BORIS		EMS-98 scale				
CR_{IT} (€/m^2)	CR_{SL} (€/m^2)	D1	D2	D3	D4	D5
1350	1250	0.02	0.1	0.35	0.6	1

Direct Losses due to Flood damage

$$ED[EUR] = PD \cdot RC \cdot A \cdot (n + b)$$

- PD (%) is the physical damage
- A [m^2] is the area of the building footprint
- n is the number of floors
- b = 1 if the building has a basement
- RC [Euro/m^2] unit replacement cost

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Boundary conditions influencing analysis and results representation

Definition of Cross-Border Study Area

e.g. several municipalities close to border

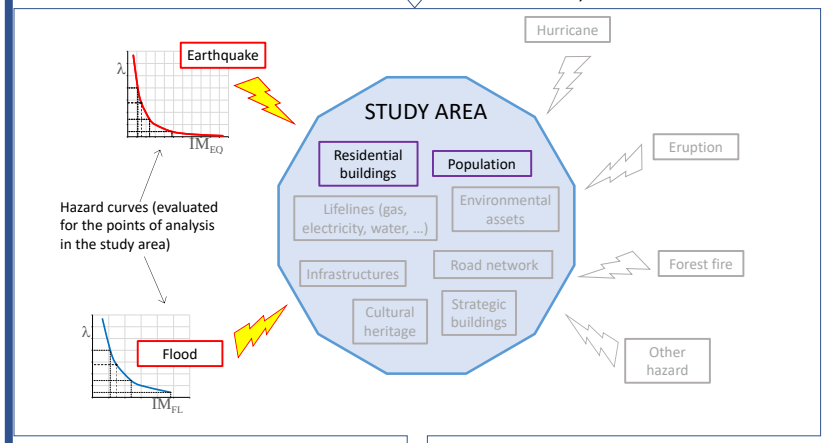
Time-frame of analysis

e.g. 50 years

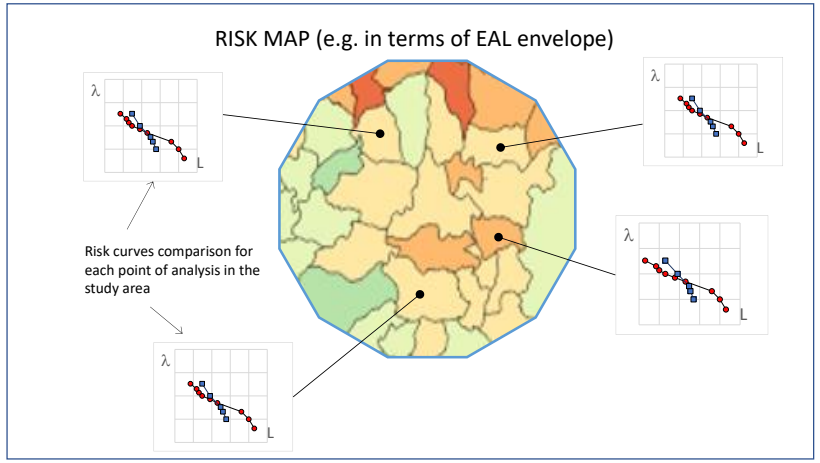
Metric for risk assessment

e.g. direct economic losses

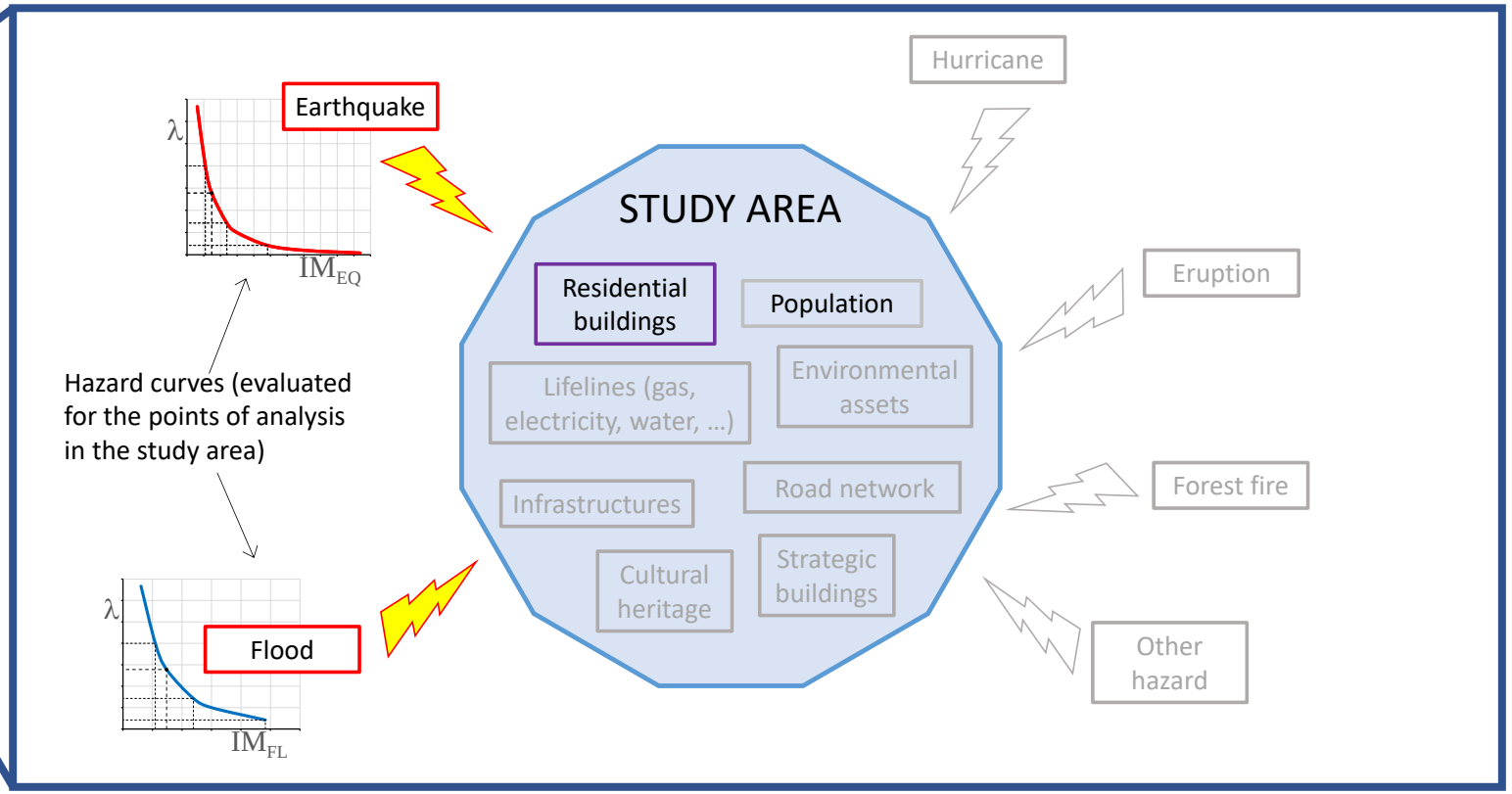
Relevant risks, hazard curves and assets



Results and representation



Relevant risks, hazard curves and assets



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The BORIS approach

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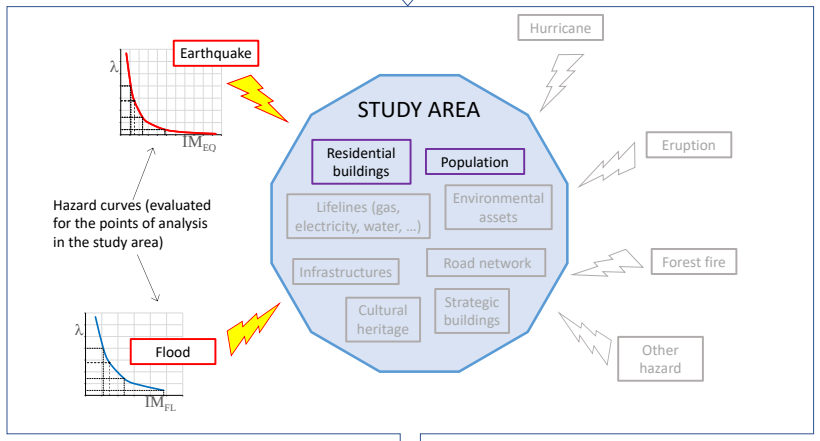

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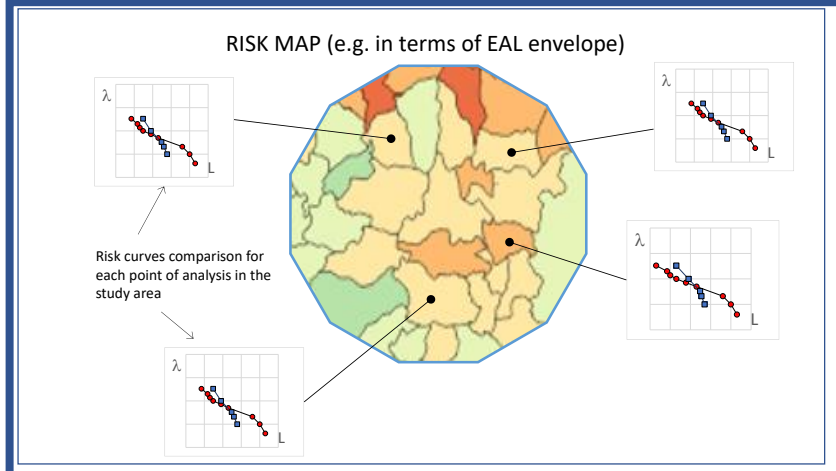

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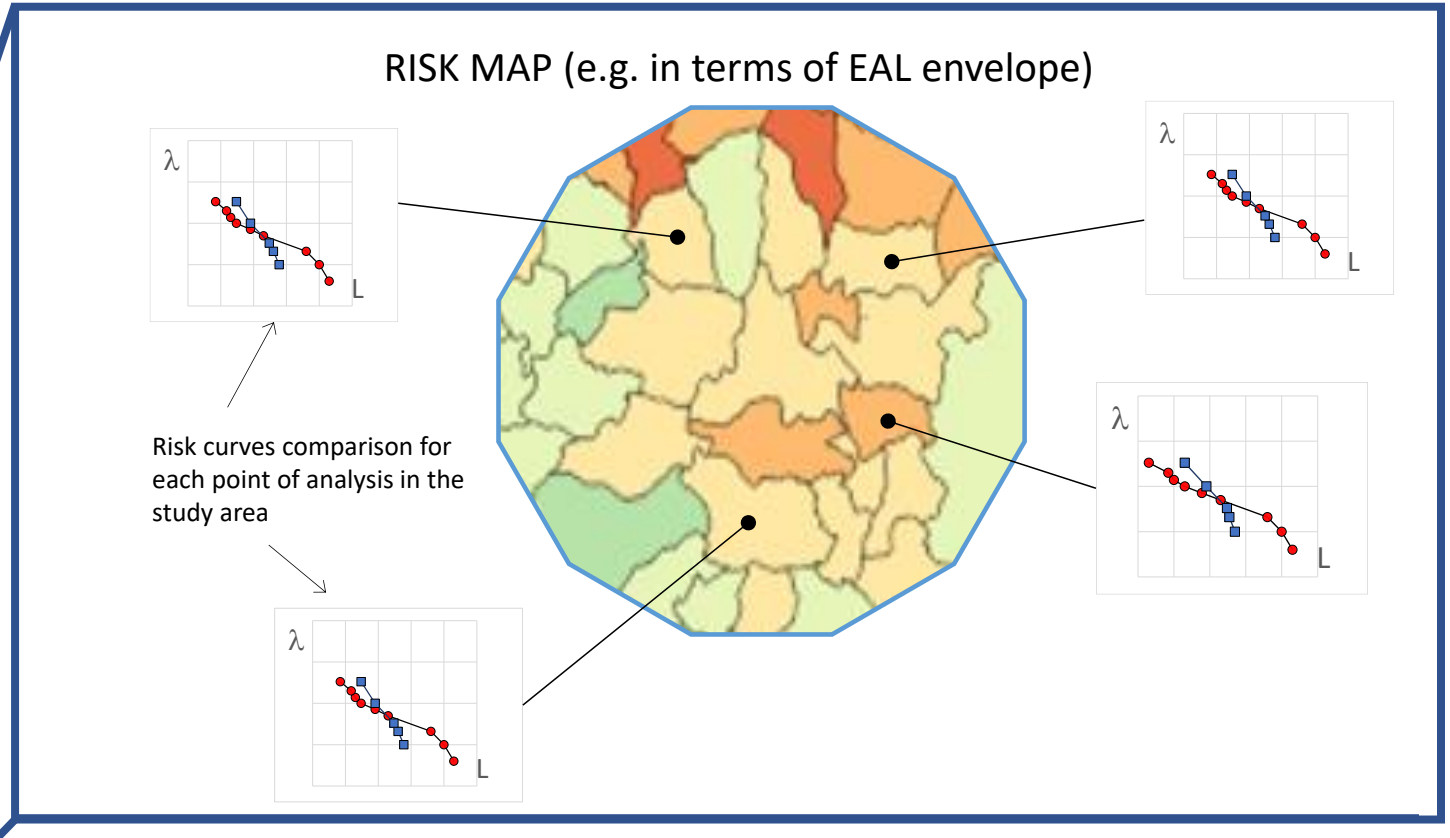

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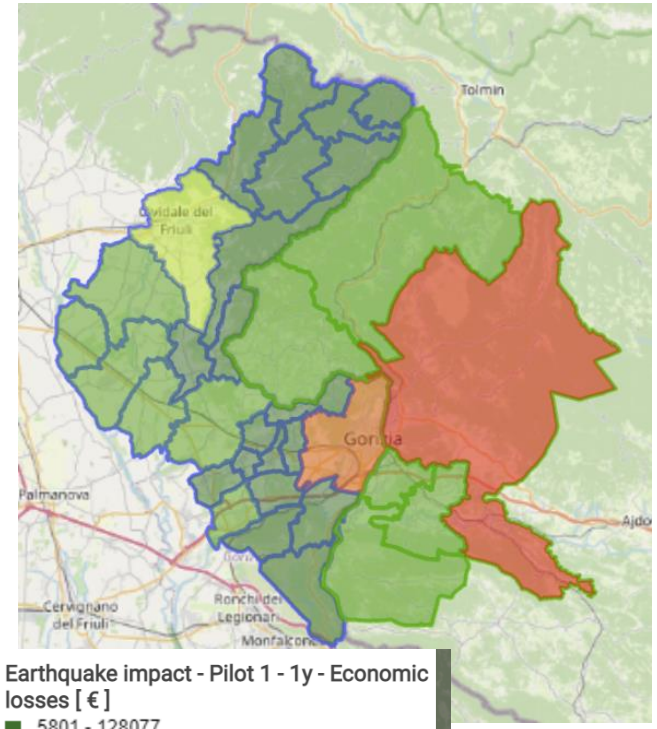
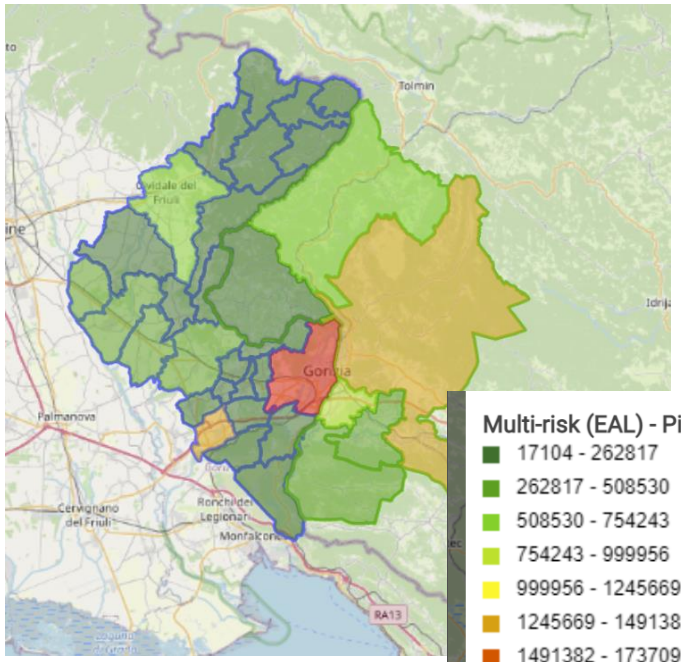
Multi-risk envelope maps

EAL (Euro) – EQ



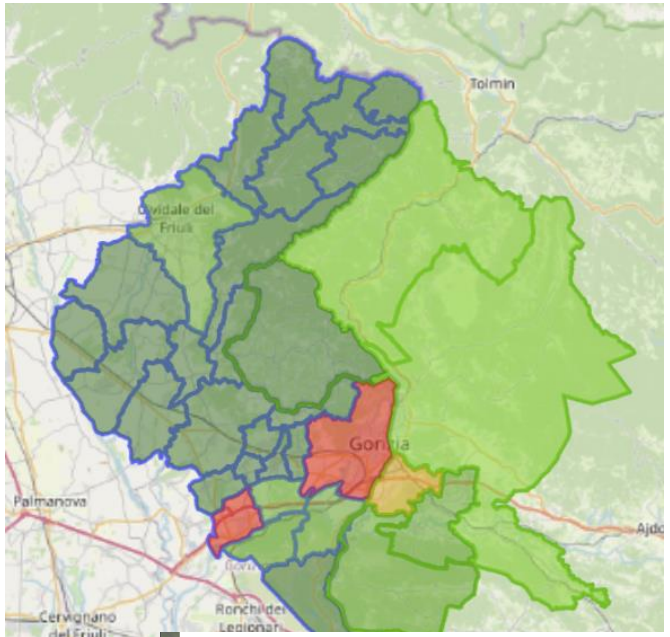
Earthquake impact - Pilot 1 - 1y - Economic losses [€]
- 5801 - 128077
- 128077 - 250354
- 250354 - 372630
- 372630 - 494907
- 494907 - 617183
- 617183 - 739460
- 739460 - 861737
- 861737 - 984013

EAL (Euro) – EQ + flood



Multi-risk (EAL) - Pilot 1 [€]
- 17104 - 262817
- 262817 - 508530
- 508530 - 754243
- 754243 - 999956
- 999956 - 1245669
- 1245669 - 1491382
- 1491382 - 1737095
- 1737095 - 1982808

EAL (Euro) – flood



Flood impact - Pilot 1 - 1y - Economic losses [€]
- 0 - 145365
- 145365 - 290729
- 290729 - 436094
- 436094 - 581458
- 581458 - 726823
- 726823 - 872187
- 872187 - 1017552
- 1017552 - 1162917

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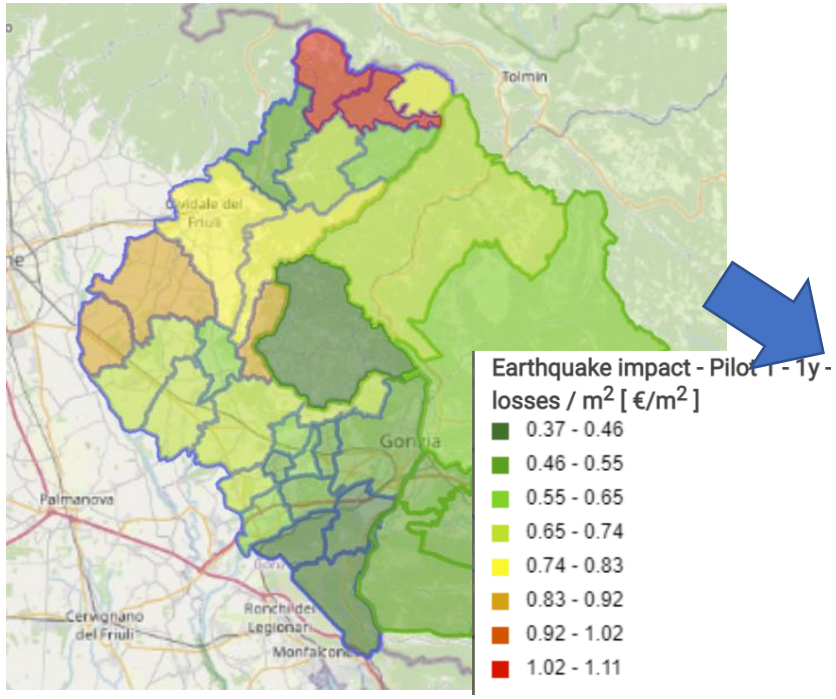
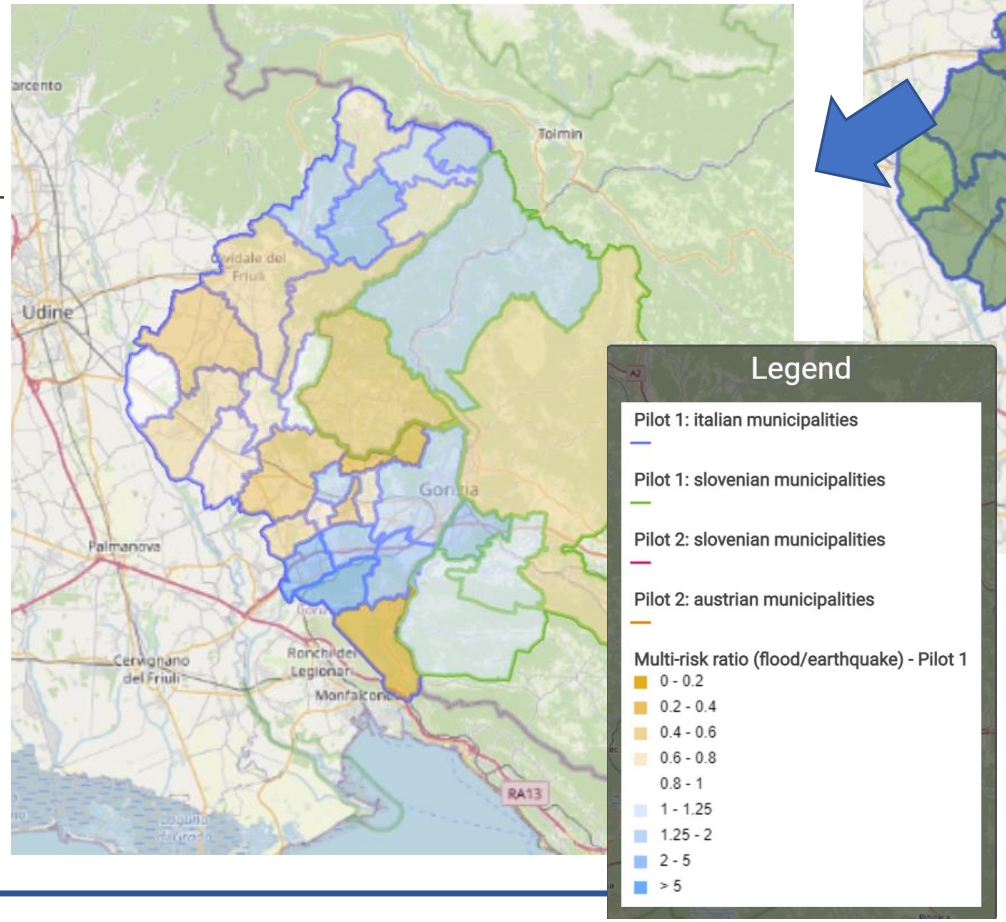
Multi-risk ranking maps

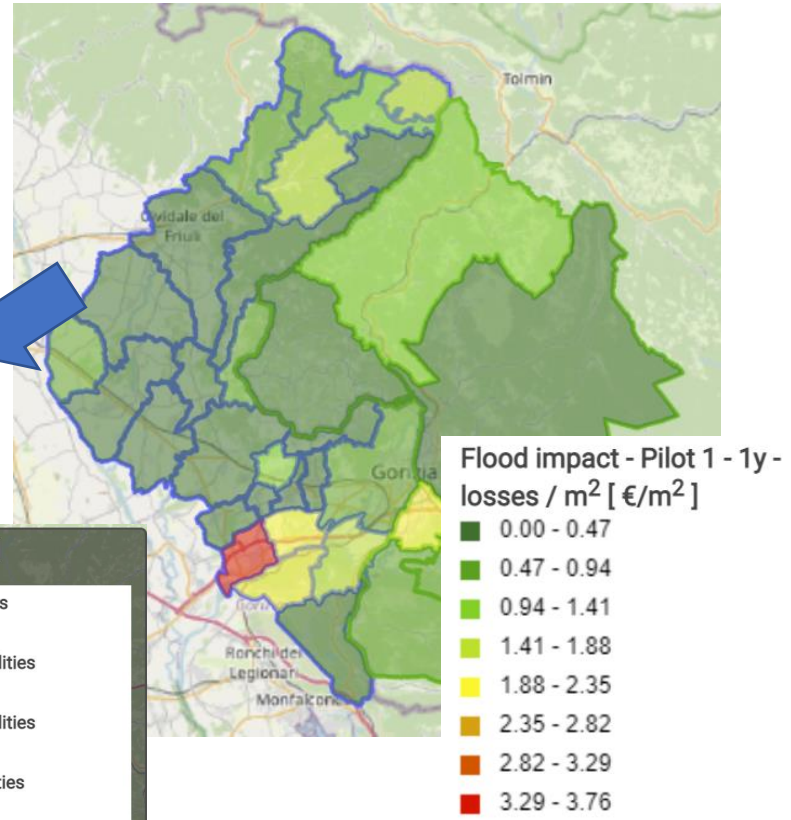
EAL (Euro/m2) – EQ



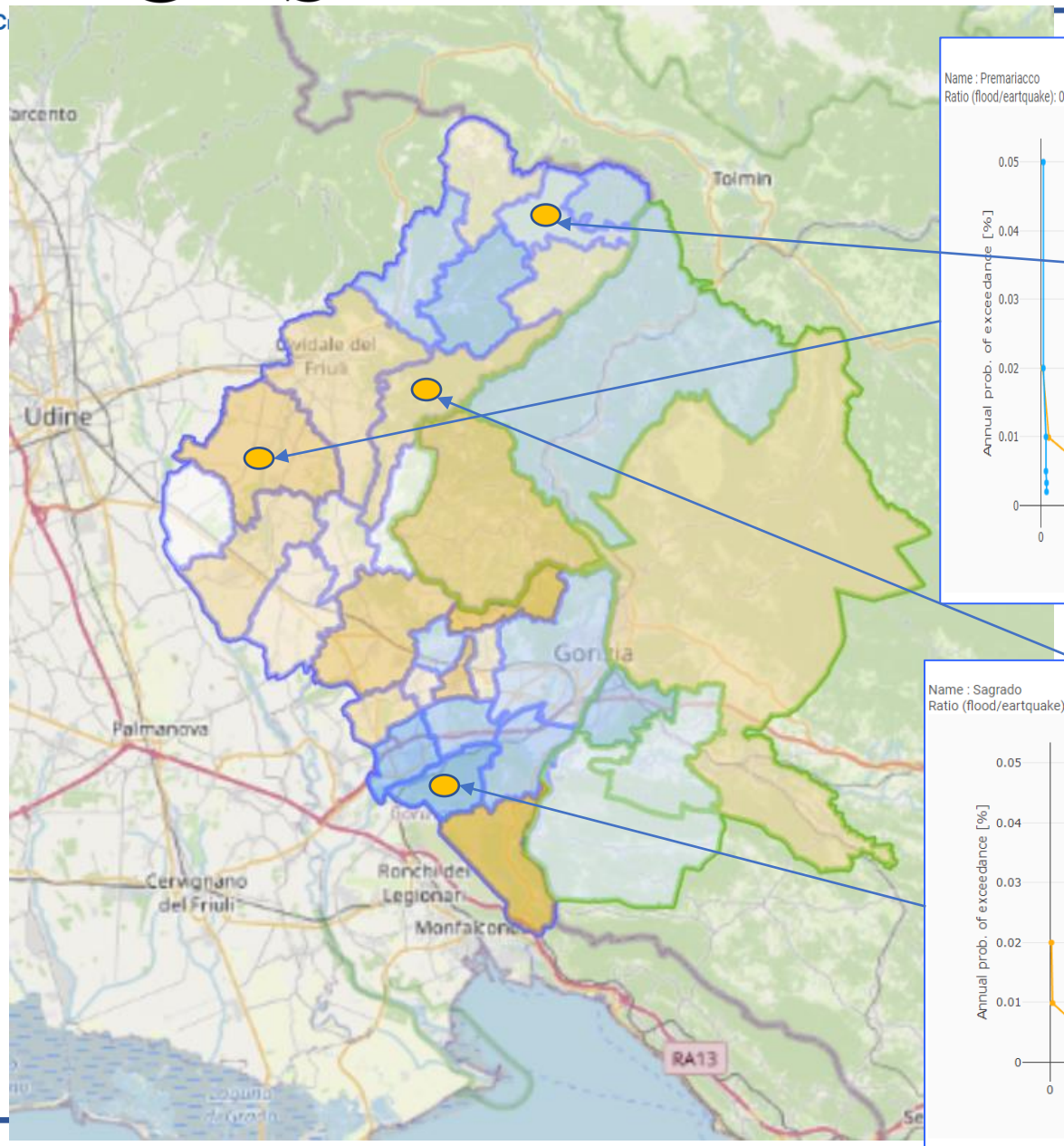
Ratio EAL_{flood}/EAL_{EQ}

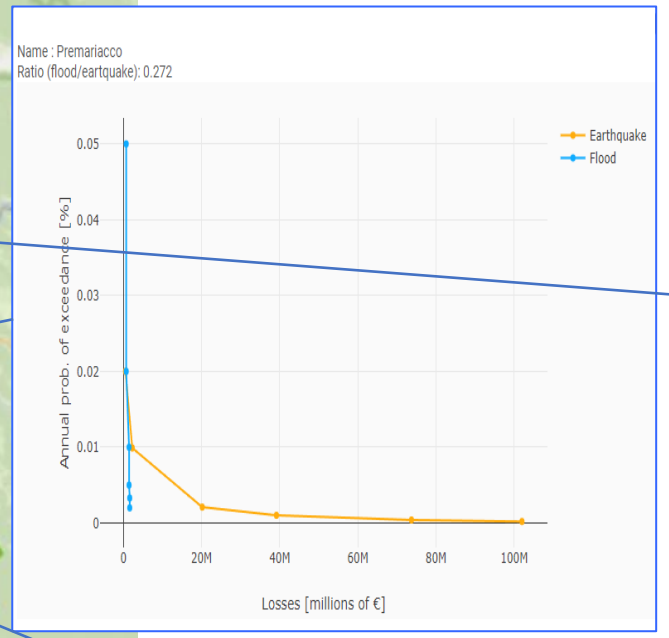


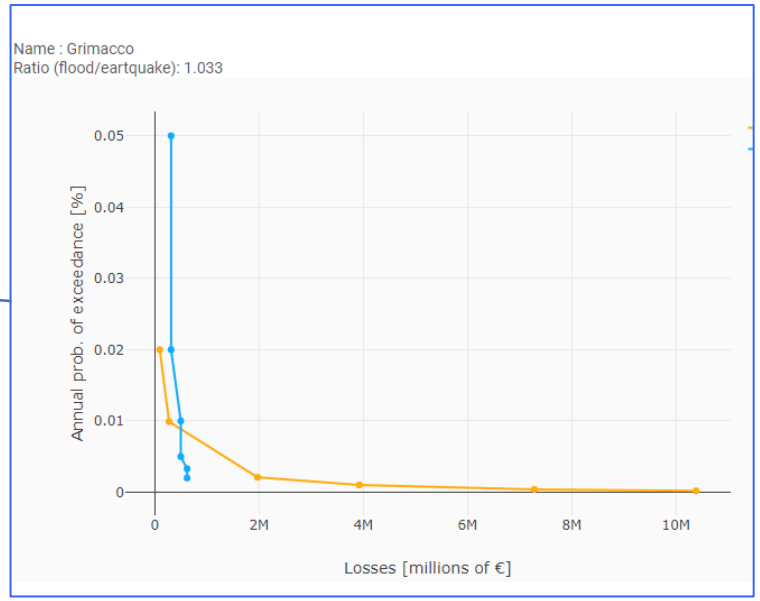
EAL (Euro/m2) – flood

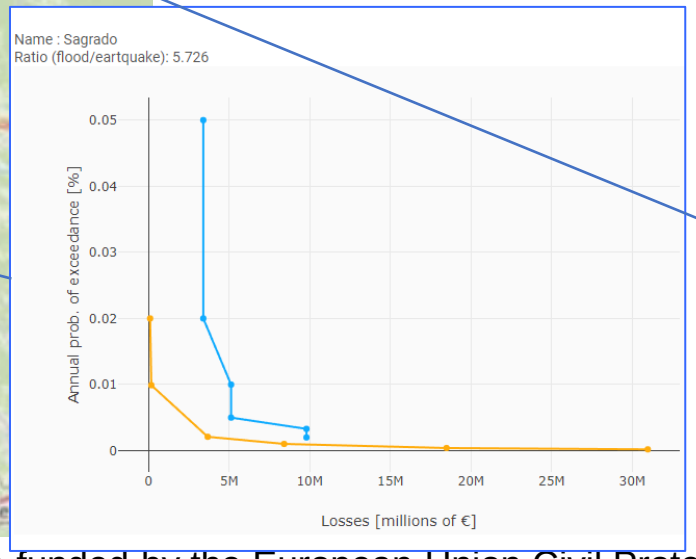


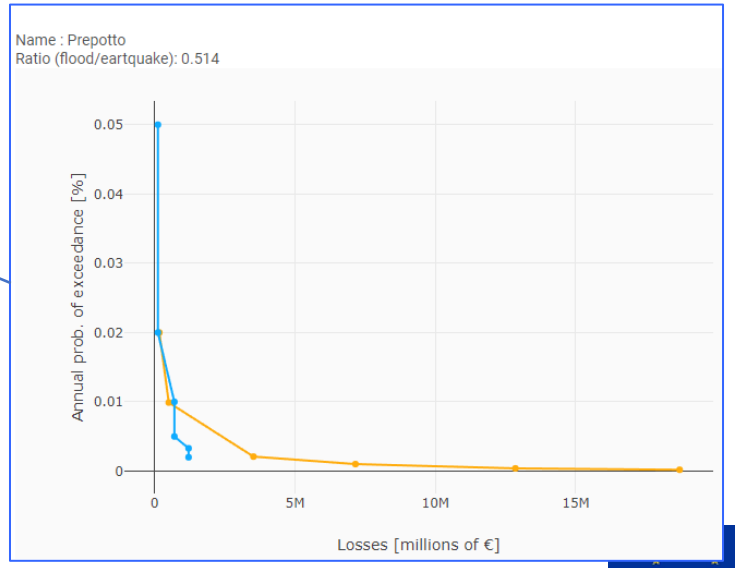
Multi-risk – comparing risk curves











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Thank you!

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