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Probabilistic and deterministic evaluation of uncertainty in a local scale multi-risk analysis

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We performed a probabilistic multi-risk analysis (QPRA) at the local scale for a 420 km2 area surrounding the town of Brescia (Northern Italy).

We calculated the expected annual loss in terms of economical damage and life loss, for a set of risk scenarios of flood, earthquake and industrial accident with different occurrence probabilities and different intensities. The territorial unit used for the study was the census parcel, of variable area, for which a large amount of data was available.

Due to the lack of information related to the evaluation of the hazards, to the value of the exposed elements (e.g., residential and industrial area, population, lifelines, sensitive elements as schools, hospitals) and to the process-specific vulnerability, and to a lack of knowledge of the processes (floods, industrial accidents, earthquakes), we assigned an uncertainty to the input variables of the analysis.

For some variables an homogeneous uncertainty was assigned on the whole study area, as for instance for the number of buildings of various typologies, and for the event occurrence probability. In other cases, as for phenomena intensity (e.g.,depth of water during flood) and probability of impact, the uncertainty was defined in relation to the census parcel area. In fact assuming some variables homogeneously diffused or averaged on the census parcels, we introduce a larger error for larger parcels.

We propagated the uncertainty in the analysis using three different models, describing the reliability of the output (risk) as a function of the uncertainty of the inputs (scenarios and vulnerability functions). We developed a probabilistic approach based on Monte Carlo simulation, and two deterministic models, namely First Order Second Moment (FOSM) and Point Estimate (PE).

In general, similar values of expected losses are obtained with the three models. The uncertainty of the final risk value is in the three cases around the 30% of the expected value. Each of the models, nevertheless, requires different assumptions and computational efforts, and provides results with different level of detail.